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POSTOPERATIVE PULMONARY SUBVENTILATION[1]

M. PRINZMETAL, M.A., S. BRILL, M.D.,[2] AND C. D. LEAKE, PH.D., SAN FRANCISCO, CALIFORNIA

Abdominal section is a hit below the belt and the patient is always winded by it.—W. Pasteur, 1910

THE significance of atelectasis as an important postoperative complication is now well recognized. The numerous factors which play a part in the production of atelectasis have been discussed previously (4). It is our purpose here to indicate some of the causes of pulmonary subventilation and to point out the relationship between this condition and postoperative atelectasis.

The etiology of atelectasis has attracted the attention of many workers. It is now fairly well accepted that atelectasis results from bronchial obstruction, as shown by the work of Coryllos and Birnbaum, Brunn and Brill, and others.

It is generally recognized that it is an upper abdominal operation that predisposes to atelectasis. Sise (21), for example, found that postoperative lung complications occurred after 0.5 per cent of operations on the extremities, 1 per cent after operations on the lower abdomen and 10 per cent after operations on the upper abdomen. A. L. Brown (3) and others have found a similar distribution. Studies on the vital capacity have given parallel findings (8). Head, for example, found an average reduction in vital capacity of 8 per cent after hæmorrhoidectomy while it was reduced from 78 to 88 per cent after operations on the stomach. It was first thought that such a fall in vital capacity after abdominal operation was due in part to the pain of vigorous respiration following surgery. But Sise (22) has pointed out that the deep respiration induced by carbon dioxide inhalation does not cause excessive pain in the postoperative patient.

William Pasteur (16) in 1908 showed that there was a limitation of motion of the diaphragm after upper abdominal operations. Recently Muller, Overholt and Pendergrass (14) studied this question more thoroughly in 25 selected cases of upper abdominal operations on the stomach and gall bladder. They found diminished expansion at the bases of the lungs in all cases; in 80 per cent there were suppressed breath sounds, in 20 per cent bronchial breathing, and in 56 per cent râles. Yet only three of their patients had cough and dyspnœa. They concluded that these changes can be considered as a normal accompaniment of every upper abdominal operation and named the syndrome: pulmonary hypoventilation.[3]

We have been interested in the relationship between upper abdominal operations and these described changes in pulmonary physiology. Our method was to study in the same animal the effect on pulmonary compression of various surgical procedures such as anæsthesia, abdominal incision, traction on ab-

[1] Read before the sixteenth annual Clinical Congress of the American College of Physicians, April 7, 1932, San Francisco. From the Department of Surgery, Division of Thoracic Surgery and the Pharmacological Laboratory, University of California Medical School, and supported in part by the J. J. and Nettie Mack Foundation.

[2] December 27, 1899—January 23, 1932. This paper is respectfully dedicated to the memory of Dr. Brill by his collaborators.

[3] A more consistent term would be "pulmonary subventilation," and since the latter would also avoid the possibility of confusing "hypo" with "hyper," it was decided to employ it in this paper.

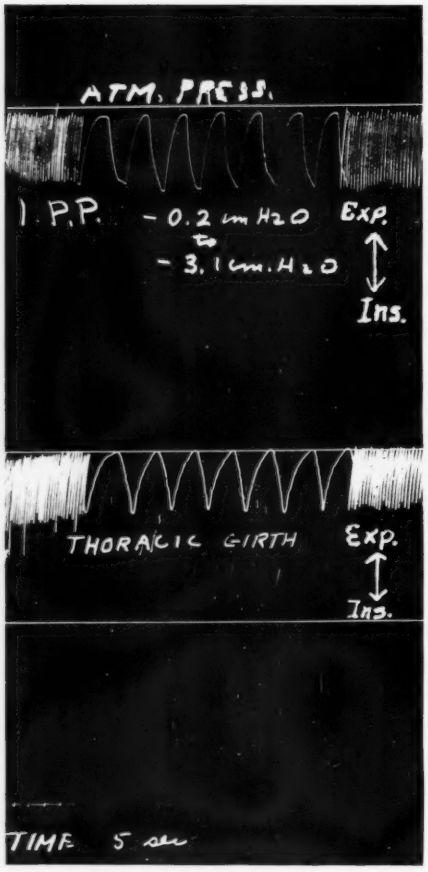

Fig. 1. Kymographic tracing of intrapleural pressure and respiratory movement in a normal unanæsthetized dog. The downstroke in both tracings is made on inspiration and the upstroke on expiration. *I.P.P.* indicates intrapleural pressure. Figures are in centimeters of water.

dominal viscera, and pressure on the abdomen. The state of pulmonary compression or distention was determined by means of intrapleural pressure. Trochars were placed in the intrapleural cavities of the dogs, and by means of branched tubing both manometric and kymographic records were obtained. We also made blood pressure observations.

Figure 1 shows what may be considered a normal curve. As is well known, intrapleural pressure is normally subatmospheric due to the stretch of the elastic lung tissue. During inspiration as the thorax is enlarged, there is greater stretch and the pressure becomes more subatmospheric. During expiration, it becomes more positive since the stretch is reduced but normally it is still subatmospheric. Thus, the greater the lung is compressed, the more positive does the intrapleural pressure become; the more the lung is distended by a deep inspiration, the more subatmospheric or negative does it become. A pneumograph was placed on the dog's chest in order to determine the relative expiratory or inspiratory position of the thorax.

The first surgical procedure we studied was ether anæsthesia (1). The effect is quite complicated (Fig. 2). At first there is violent respiratory movement which corresponds to the second stage of anæsthesia. As the animal goes into the third stage of anæsthesia, one notes a gradual and very definite rise in intrapleural pressure accompanied by a gradually decreasing thoracic girth. A rise in intrapleural pressure means less lung distention or relative lung compression. This may be due to paralyses of the intercostal muscles in the face of a constant lung elasticity, for in deep third stage anæsthesia the intercostal muscles can be seen to be sucked in, during inspiration.

Abdominal incision further increases intrapleural pressure (Fig. 3). This might be explained by Overholt's theory that pulmonary subventilation is due to pneumoperitoneum which he thinks occurs after abdominal incision (15). The intraperitoneal pressure is normally subatmospheric and he has found it increases somewhat after abdominal incisions. Pneumoperitoneum occurs after many surgical procedures as can be seen in Figure 4.

Assistants often get tired during a surgical operation and may rest on the abdomen. This further increases intrapleural pressure or causes further lung compression as may be illustrated by reference to Figure 5. Clinical evidence is here afforded of the possibly harmful effects of thoughtless leaning on a patient's abdomen during an operation.

Traction on any abdominal viscus like the stomach or mesentery further increases the pressure and causes more pulmonary compression (Fig. 6). It is suggested that

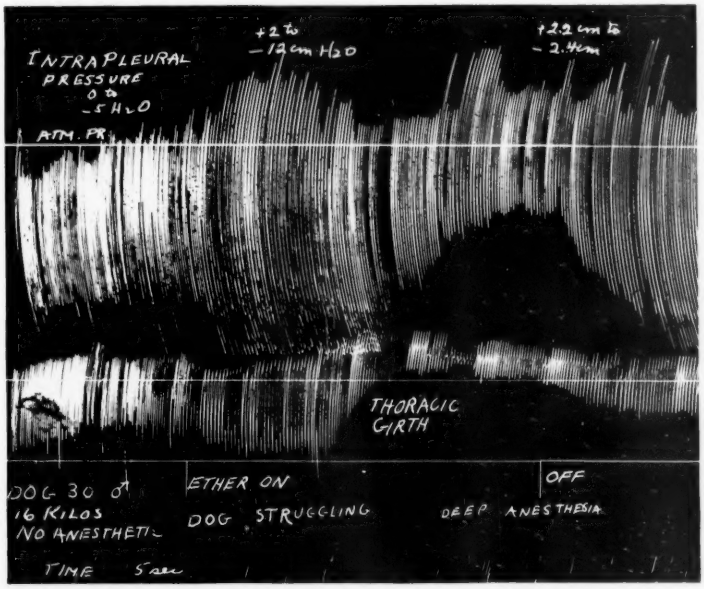

Fig. 2. Kymographic record of intrapleural pressure and thoracic girth in a dog showing effects of ether. The intrapleural pressure is increased and the thoracic girth decreased in deep anæsthesia.

during operations in which an organ is put on a continuous stretch, there must be a marked effect on respiration.

To the question, are these changes purely reflex and do they disappear after the abdomen is closed and anæsthesia stopped, the answer is apparently no, as may be deduced from data offered in Table I. Before surgery the intrapleural pressure was —3 centimeters water to —8 centimeters water. After the anæsthesia was stopped and the abdomen closed the pressure was +3 to —6. The total increase in intrapleural pressure at the end of expiration in this case was 6 centimeters of water. The cause of the increased intrapleural pressure is probably the rise in the diaphragm which Pasteur (16) first described in 1908. A roentgenogram of a normal pre-operative chest is shown in Figure 7. After surgery it can be seen that the diaphragm has risen somewhat causing the heart to assume a more horizontal position but the mediastinum has not shifted (Fig. 8). It is the base of the lung that suffers most, and as a result, bronchial breathing and râles might be heard in a case like this. It should be emphasized that bronchial breathing, diminished expansion, and râles heard at the bases of the lung following abdominal surgery do not necessarily mean pneumonia.

Pulmonary subventilation also occurs in other conditions. Pasteur (17) in 1890 studied

TABLE I.—INTRAPLEURAL PRESSURE CHANGES IN DOG DURING GASTRO-ENTEROSTOMY

Time		Intrapleural pressure expiration cm. H_2O	Intrapleural pressure inspiration cm. H_2O
1:59	Before ether	−3	−8
2:00	Anæsthesia started, dog struggling	+3	−20
2:05	Deep anæsthesia	+2	−7
2:20	Peritoneum opened	+2.5	−7
2:30	Gastro-enterostomy	+3	−6
2:40	Gastro-enterostomy	+3	−6
3:00	Peritoneum closed	+3	−6

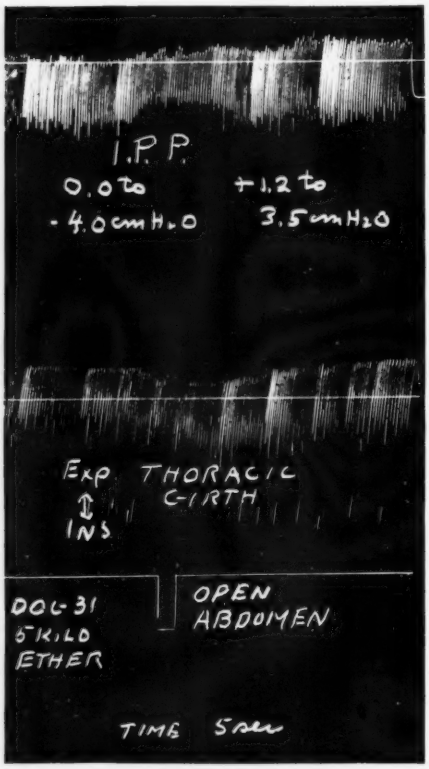

Fig. 3. Kymographic record of intrapleural pressure and thoracic girth in a dog under ether anæsthesia showing effect of opening the abdomen.

15 cases of diphtheritic paralysis of the diaphragm. He found percussion dullness and bronchial breathing in many of the cases but at autopsy he found atelectasis. Elderly patients who have been bedridden for some time due to such conditions as typhoid fever or fractured neck of the femur suffer from pulmonary subventilation. It also occurs in tympanites as is seen in this case (Fig. 9). After the tympanites has been removed by suitable treatment the diaphragm again assumes its normal level (Fig. 10).

The increased intrapleural pressure induced by surgery might be expected to have a profound effect on circulation. Physiologists have long recognized the importance of the negative pressure in the thorax in aiding venous return. An increased intrapleural pressure would therefore impair venous return. Lister has suggested that venous stasis is an important factor in the formation of postoperative emboli. Kountz, Alexander, and Dowell (10) found that the increase in intrapleural pressure in emphysema causes an increased venous pressure. The increase in intrapleural pressure causes a lowering of arterial blood pressure (Fig 11). Pulmonary subventilation might therefore be a factor in the lowering of arterial blood pressure found after surgery.

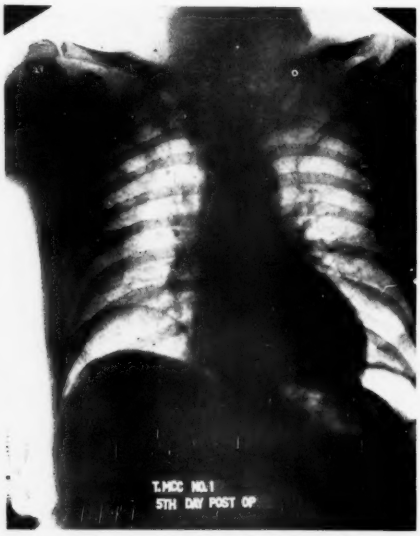

Fig. 4. Pulmonary subventilation produced by a pneumoperitoneum after abdominal operation.

The pulmonary compression induced by surgery helps explain the decrease in vital capacity found after abdominal operation. Pulmonary compression is also an adequate explanation for diminished expansion, râle and bronchial breathing or diminished breath sounds heard at the base of the lungs which Muller, Overholt, and Pendergrass found after an upper abdominal surgery (14).

Carbon dioxide inhalations have been found to be a great aid in both the prevention and treatment of postoperative complications. Carbon dioxide causes a decrease in intrapleural pressure (20) to its normal subatmospheric level thus counteracting the effects of surgical procedures (Fig. 12). If atelecta-

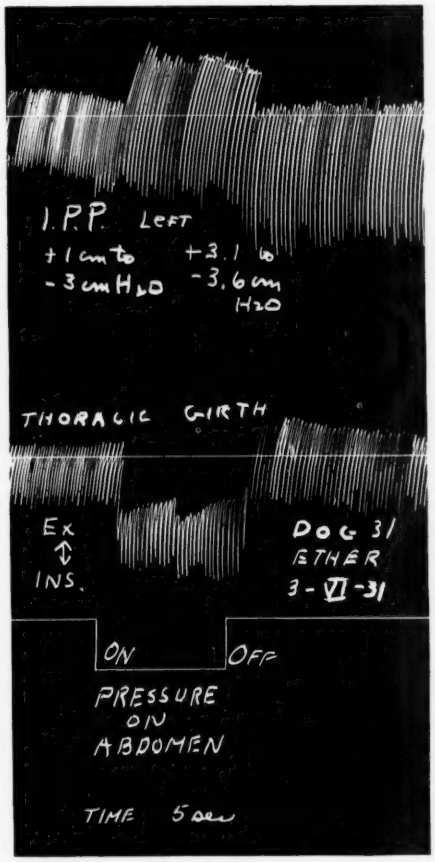

Fig. 5. Kymographic record of intrapleural pressure and thoracic girth in a dog under ether anæsthesia showing effects of pressure on the abdomen. *I.P.P.* figures indicate intrapleural pressure in centimeters of water.

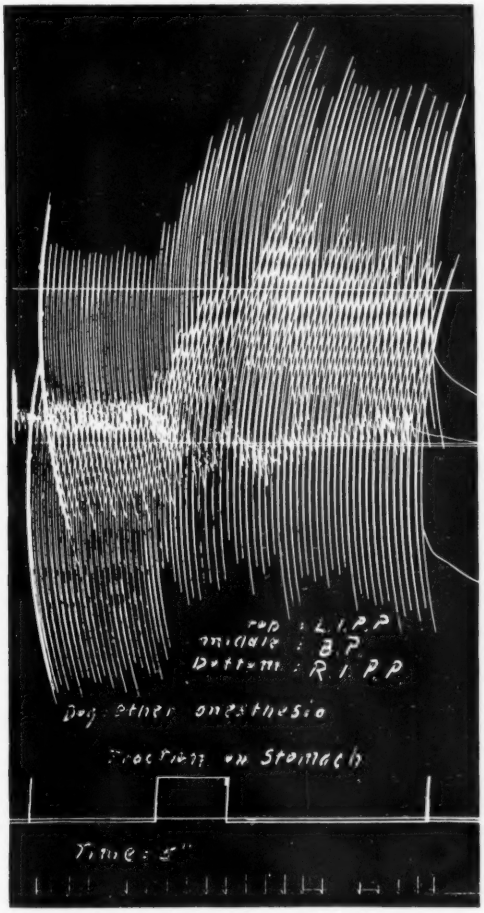

Fig. 6. Kymographic record of intrapleural pressure in both chests and blood pressure showing effects of traction on the stomach.

has already occurred the decreased intrapleural pressure induced by carbon dioxide might be expected to help distend the collapsed lung. Of course, there are other reasons why carbon dioxide is an efficacious treatment. It dilates the bronchi (2), raises blood pressure (11), and increases ventilation. The effect on intrapleural pressure seems almost specific in counteracting the harmful effects of surgery on pulmonary physiology.

What is the relationship between the conditions of pulmonary subventilation and obstructive atelectasis? It is suggested that pulmonary subventilation is an etiological factor in the production of real atelectasis. Lung compression and decreased ventilation will favor the accumulation of secretion and thus prevent proper lung drainage, thereby leading to the production of mucous plugs. The importance of diagnosing this condition and of administering the proper treatment is therefore evident.

The distinction between pulmonary subventilation and postoperative atelectasis is demonstrated in Table II.

Fig. 7. Roentgenogram demonstrating the normal chest of a patient before operation.

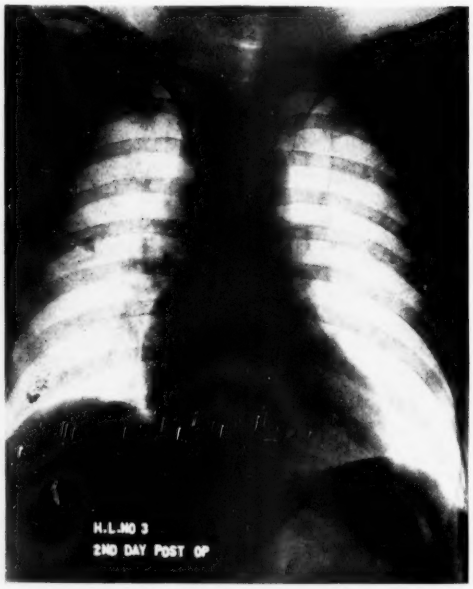

Fig. 8. Same patient as in Figure 7 after abdominal operation. Note increase in the height of the diaphragm and increased thoracic girth.

Fig. 9. Tympanites present after operation and producing pulmonary subventilation. Note the position of the diaphragm.

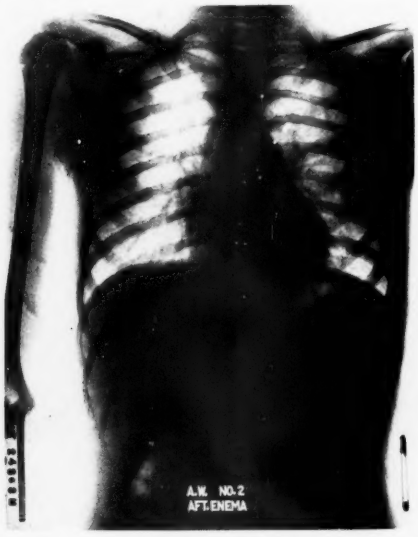

Fig. 10. Same patient as in Figure 9 showing return diaphragm to a more normal position after the tympanit was relieved by enema.

TABLE II.—DISTINCTION BETWEEN PULMONARY SUBVENTILATION AND POSTOPERATIVE ATELECTASIS

	Pulmonary subventilation	Atelectasis
Incidence	Occurs after 100 per cent of abdominal operations	Occurs after about 4 per cent of abdominal operations
Intrapleural pressure	Increased	Greatly decreased
Distribution	Bilateral	Usually unilateral
Etiology	High diaphragm and lung compression	Mucous plug
Thorax	Enlarged	Sucked in unilaterally
Mediastinum	Not changed	Shifted to the side of the lesion
Treatment	Carbon dioxide to prevent the occurrence of obstructive atelectasis	Carbon dioxide to distend collapsed lung. Bronchosopy if medical treatment is not successful

SUMMARY

Surgical procedures on the abdomen produce pulmonary subventilation by increasing intrapleural pressure. Anæsthesia, abdominal incision, traction on abdominal viscera, and pressure on the abdomen tend to increase intrapleural pressure, which in turn may raise systemic venous and lower arterial pressure.

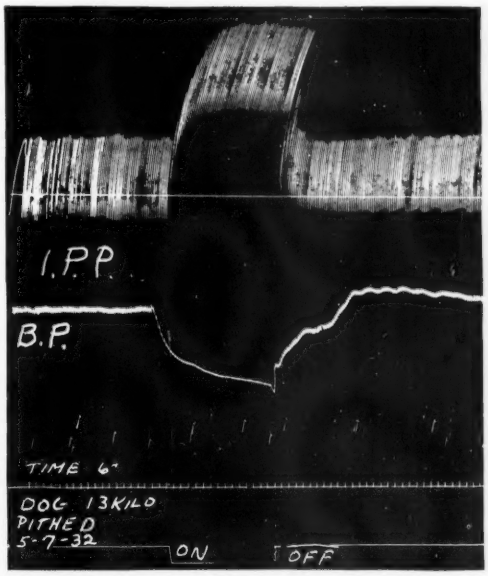

Fig. 11. Kymographic record of a pithed dog under artificial respiration showing the effect of increased intrapleural pressure on blood pressure. Intrapleural pressure was increased by an adjustment of the artificial respiration.

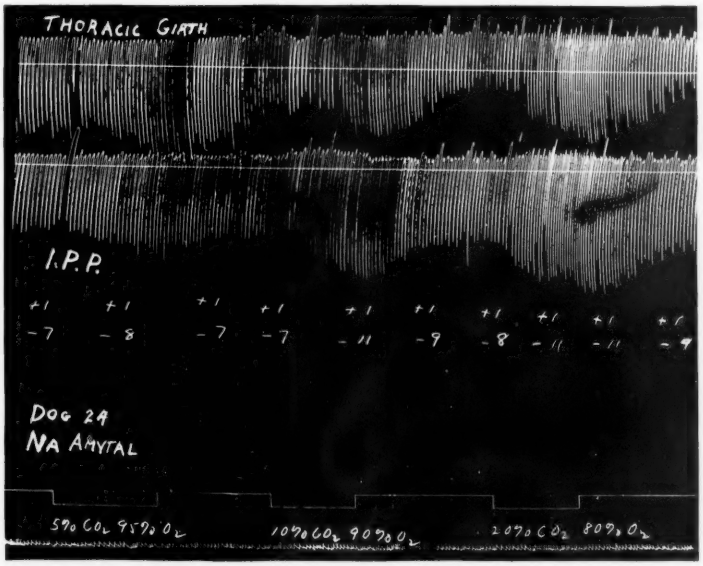

Fig. 12. Kymographic record of intrapleural pressure and thoracic girth in a dog under sodium amytal anæsthesia following the administration of different concentrations of carbon dioxide. Intrapleural pressure figures are indicated in centimeters of water.

The increased intrapleural pressure offers an explanation for the decrease in vital capacity and the signs at the bases of the lung found after surgery. Carbon dioxide has been shown to lower intrapleural pressure and, therefore, to counteract the harmful effects of surgery on respiratory physiology. The relationship between pulmonary subventilation and obstructive atelectasis is pointed out.

We desire to thank Dr. Harold Brunn for aid and advice.

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THE RÔLE OF THE PLACENTA IN THE MAINTENANCE OF HYPOPHYSEAL ACTIVITY DURING PREGNANCY[1]

HAROLD KLINGLER, M.D., J. C. BURCH, M.D., F.A.C.S., AND R. S. CUNNINGHAM, M.D., NASHVILLE
From the Departments of Gynecology and Anatomy, Vanderbilt University School of Medicine

IT HAS been known for many years that the corpus luteum is an important physiological link in the mechanism of pregnancy. This fundamental fact, in the physiology of the female reproductive mechanism, has been established by a series of beautiful studies which were inaugurated by the epochmaking discovery of Fraenkel, who, at the suggestion of Professor Born, investigated the effect of removing the corpus luteum on the maintenance of pregnancy. Fraenkel found that when the corpus luteum was removed from pregnant animals abortion took place. He concluded that this structure produced a secretion or hormone which acted directly upon the uterus to maintain the viable connection between the placenta and the maternal tissues. It is needless to review in detail the important contributions of Loeb (22, 23), Bouin and Ancel, Dubreuil and Regaud, and others. All of these investigators have advanced additional evidence which has confirmed the essential fact that the secretion of the corpus luteum is of fundamental importance in the maintenance of pregnancy. The recent investigations of Corner and Allen (1, 8) have added the final proof to this conception of the function of the corpus luteum. These investigators prepared an extract from corpora lutea which, when injected into rabbits spayed shortly after mating, allowed pregnancy to continue throughout its normal period. Furthermore, with these extracts, they produced typical progestational changes in animals previously sensitized by the injection of estrin. It seems fundamentally sound, therefore, to accept as sufficiently demonstrated that the primary function of the corpus luteum is the production of a secretion which is essential in the establishment and maintenance of early pregnancy.

It has been found by repeated experiments, both artificial and performed by nature, that, if nidation fails to occur, the corpus luteum degenerates and disappears. Whereas, if nidation does occur, the corpus luteum is stimulated and continues to function. The mechanism of this activation of the corpus luteum has eluded final demonstration until recent years. It has been through a series of studies which have been developed, largely from an entirely adventitious viewpoint, i.e., the study of the anterior lobe of the hypophysis, that definite progress has been made.

It seems logical to reason that the factor which is known to be most potent in its action on the ovary, might be expected to be the link concerned with the activation of the corpus luteum. In the inception of the work, which we wish to present in this communication, this process of reasoning lead us to consider that such a mechanism would in all probability be found to operate through the anterior lobe of the pituitary body, since numerous brilliant investigations had demonstrated the profound and fundamental nature of the control exercised by this structure upon the female reproductive organs.

The capacity of the anterior lobe of the hypophysis to produce an effect upon the ovary was demonstrated independently in 1927 by Smith and Engle and by Zondek and Aschheim. These observers found that subcutaneous implantation of anterior lobe tissue into infantile mice brought about a rapid development of the genital tract, with the premature appearance of estrus, enlargement of the ovaries, and specific changes in the uterine epithelium. The ovaries were most remarkable, the follicles had undergone rapid development, ovulation had taken place in many cases, and corpora lutea had been formed. In addition, there were numerous blood filled follicles and, in some instances, luteinization had occurred in unruptured and even in immature follicles. In addition to being of fundamental physiological importance, this reaction has been utilized as a practical basis for much of the subsequent work on the anterior lobe of the hypophysis and has con-

[1] This work has been aided by a grant from the National Research Council Committee for Research on Problems of Sex. Part of the animals used in these experiments were drawn from the rat colony which has been supported by a grant from the Commonwealth Fund.

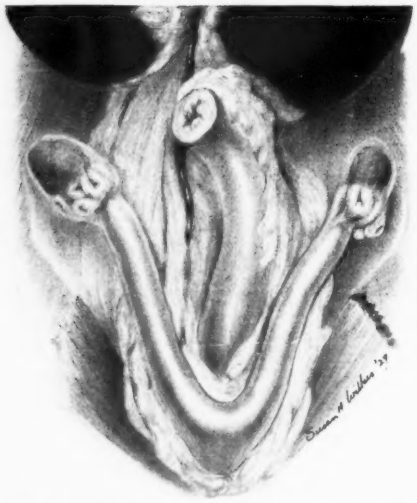

Fig. 1. Drawing of the ovaries, uterus, and tubes of normal mouse No. 51-840 after fixation in Bouin. This mouse had an index of 1.1 and was the largest normal in our series. ×6.

stituted an exceedingly delicate biological test for the presence of the hormone or hormones of this gland. It is not within the province of this paper to discuss the so called duality of the anterior lobe secretion, or the possibility, as suggested by Philipp and others, that the hormone present in the urine of pregnant women is in reality a placental hormone. Studies have been carried out by Friedman, Wolfe, and others on the relationship between the hypophysis and ovulation. In all these investigations it has been repeatedly demonstrated that the anterior lobe possesses a very powerful capacity to stimulate the production of lutein tissue in the ovary, under a variety of conditions. All of the studies which have been directed toward the solution of this particular problem have strongly supported the concept of a relationship existing between the anterior lobe and the corpus luteum.

The considerations just outlined lead to the assumption that there is probably some peculiarity in the state of pregnancy which increases the capacity of the anterior lobe of the hypophysis to stimulate the ovary, and more especially the corpus luteum. It was on this assumption that the experiments reported here were inaugurated and, since it is obvious that the placenta is the most characteristic and pertinent structure developed during pregnancy, it seemed probable that it would have some specific action on the anterior lobe. The same line of reasoning included the possibility of the controlling factor being decidual tissue or the fetus itself. The former was thought to be unimportant, since the experiments of Loeb had demonstrated that the presence of experimentally produced placentomata was insufficient to maintain the corpus luteum in a state comparable to the corpus luteum of pregnancy. The rôle of the fetus is easily excluded as a source of the unknown secretion by the consideration of hydatidiform mole and chorio-epithelioma. In these interesting conditions the endocrine activities of pregnancy are maintained after the fetus has been expelled from the body.

The capability of the placenta to produce a hormone was first suggested by Halban who from clinical observations, reasoned that the placenta was a gland of internal secretion. In the following year, Lane-Claypon and Starling made a weak aqueous extract from placenta and fetus, and found that this extract had a definite effect on the mammary gland. Later, extracts potent in the estrus producing hormone, were made by Hermann, Iscovesco, Frank, Allen and Doisy, and many others.

The estrus producing substance furnished by the placenta has been studied extensively and it has been shown that this substance is similar to the hormone of the ovarian follicle in the biological reactions which it produces. In 1920, Hirose demonstrated that the intraperitoneal injections of placenta produced marked changes in the ovaries of rabbits. The increase in number and size of the corpora lutea was especially noteworthy. These changes were obtained with fresh placenta, but were not obtained with the ether or alcohol extracts. He also found that this effect was obtained only from placentæ of the first half of pregnancy. Hirose's paper has not been available to us in the original; the information here given was obtained from the paper by Murata and Adashi, who have confirmed and extended Hirose's experiments.

They found that, if the animals had been previously spayed, they could not produce an enlargement of the uterus by placental extracts, and concluded that the estrin content of placental material was not responsible for the change, but rather that the placental material had, in some way, influenced the ovary to increase its own production of estrin. Zondek and Aschheim, in addition to their discovery of the ovary stimulating hormone in the blood and urine of pregnant women, found that implants of small amounts of placental tissue produced a somewhat similar action. Wiesner prepared an extract from human placenta, by extracting it with sulphosalicylic acid, which contained a considerable amount of the ovary-stimulating hormone and also some growth hormone.

In considering the evidence presented, it was felt that the mechanism for the maintenance of hypophyseal activity must reside in the placenta; the secretion of the placenta stimulating the hypophysis and that of the hypophysis in turn stimulating the ovary. With this thought in mind, Burch and Cunningham carried out a series of experiments which were reported in a previous paper in 1930. These experiments were conducted as follows: A commercial alcoholic extract of placenta was obtained and this material was injected into a series of spayed rats. These rats were later killed and the hypophyses removed and transplanted into the subcutaneous tissues of infantile mice. The mice were given two transplants, each consisting of the entire anterior lobe from a rat which had been treated as already outlined. These mice were sacrificed on the fourth day and the genital tracts studied. A series of control experiments were also carried out. These consisted of mice into which hypophyses of spayed rats, which had not been injected with the extract, were transplanted. In these experiments it was found that the size of the ovaries in the animals of the experimental group were approximately three times larger than those of the control animals. These experiments are being reported in detail in this paper (see Tables I, II, and III). The extract which was used was obtained in several shipments. The estrin content was carefully

Fig. 2. Drawing of ovaries, uterus and tubes of control mouse No. 41–792 after fixation in Bouin. This animal had an index of 2.6, which is approximately the average of this group. ×2.7.

standardized as, at that time, estrin was considered to be the most important of the various substances known to be present in the placenta. This extract was prepared by alcoholic extraction of fresh human placenta and, as it was in the experimental stage, there was some variation in the method of preparation which, however, did not differ in the fundamental use of alcohol as a preliminary solvent. The variation in the method used in preparing the extracts may account for the marked variation which we obtained in the individual animals in this series of experiments. Kraul has approached the problem from much the same viewpoint as our own. He employed the histology of the ovary as a measure of the activity of the anterior lobe. He concludes that the follicular growth of animals receiving hypophyses from donor animals previously treated with folliculin or placenta extract is variable but sometimes increased.

Following our report, it was shown by Leonard, Meyer, and Hisaw that the ovary stimulating capacity of the anterior hypophysis was diminished by repeated injections of estrin over a long period of time. Kunde, d'Amour, Gustavson, and Carlson obtained

Fig. 3. Drawing of ovaries, uterus, and tubes of experimental mouse No. 46–835. This animal had an index of 16.7 and was one of the three largest of this group. Note the large bursa on each ovary. ×6.

the estrin hormone from the urine of pregnant women and injected this daily into immature dogs over a period of 6 to 17 weeks. They found that the anterior lobes of these dogs were much smaller than those of normal dogs and that the ovaries were also smaller than normal. These experiments indicate very clearly that estrin could not have been the material that produced the changes which we observed in our previous experiments. It is to be noted here that we could not determine the nature of the mechanism involved and, as stated in our paper, "the stimulating effect produced on the anterior lobe was increased by an extract of placenta which contained a high concentration of estrin." The experiments referred to have clearly demonstrated that estrin could not have been the responsible agent in our previous extracts.[1]

In 1930 there appeared a series of studies by Collip (5, 6, 7), on the placenta, which offered a wholly new line of approach and interpretation for the work which we have referred to. Collip has extended the studies of Wiesner and has, by means of alcohol, acetone, and ether extractions, obtained three

[1] See discussion, J. Am. M. Ass., 1931, xcvii, 1865–1867.

Fig. 4. Photograph of normal animal No. 51–840 and experimental animal No. 46–835, after fixation in Bouin. ×2.

fractions which are relatively specific in character. The original extraction was made with acetone. After concentration and removal of the acetone *in vacuo* he subdivided his fractions according to their solubilities in alcohol, ether, and water. One fraction which he obtained contained estrin. The second he has called the "anterior pituitary-like substance" and has found that its action is biologically similar to the ovary stimulating hormone which is found in the urine of the pregnant and in the substance of the anterior lobe of the hypophysis. His third fraction he has called "emmenin." This substance has an estrogenic action which is not interfered with by the removal of the hypophysis. Evans, Meyer, and Simpson have shown that the urine of pregnant women contains a substance which activates the hypophysis in regard to its ovary stimulating capacity. This substance they have designated as "prolan," after Zondek and Aschheim. It is possible that this is the substance which was the active principle in our original extracts. It seems from the experiments which we are reporting in the second part of this paper that our original hypothesis of placental stimulation of the hypophysis is correct and that the active agent is either emmenin or the substance resembling that from the anterior pituitary gland or a combination of one or both of these with estrin.

FIRST SERIES OF EXPERIMENTS

All of the tables are arranged in the same fashion and therefore a general statement

TABLE I.—NORMALS

Number	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
51–840	10	0.8 x 1.4 x 1.0	1.1	...	...
70–923	9	0.8 x 1.1 x 0.6	.5	...	...
72–925	9	0.5 x 0.75 x 0.8	.3	...	...
73–926	9	0.5 x 1.0 x 0.8	.4	...	...
		Average	.6		

TABLE II.—FIRST SERIES. CONTROLS

Number	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
12–659	12	1.0 x 1.0 x 1.6	1.6	135	19
13–660	12	1.3 x 1.4 x 1.2	2.2	148	19
22–704	12	2.0 x 1.8 x 2.0	7.2	131	19
23–705	10	1.2 x 1.6 x 1.1	2.1	160	19
29–790	10	1.4 x 1.2 x 2.0	3.4	120	22
30–791	10	1.2 x 1.3 x 1.0	1.6	145	22
31–792	10	1.2 x 2.0 x 1.1	2.6	146	22
32–793	10	1.1 x 1.9 x 0.9	1.9	140	22
33–794	10	1.0 x 2.2 x 1.2	4.2	145	22
34–795	10	1.3 x 2.0 x 2.1	5.5	120	22
35–796	10	1.2 x 1.6 x 1.6	3.1	130	22
66–919	12	0.8 x 1.4 x 0.7	0.8	110	22
67–920	12	1.2 x 2.1 x 1.1	2.8	139	22
68–921	10	0.9 x 1.4 x 1.6	2.0	124	22
69–922	9	1.0 x 1.4 x 1.2	1.7	126	22
		Average	2.9	138	21

regarding the data included in them seems advisable. The ovaries were fixed in a uniform manner, dehydrated, and embedded as carefully as possible, and serially sectioned at seven microns. The largest section was measured by a micrometer eyepiece which had been standardized against a micrometer slide and the number of sections obtained from each ovary counted and multiplied by seven; in this manner three dimensions of the ovary were obtained which, when multiplied together, gave the "index." This index is not an accurate measure of size, but we feel that it is more accurate for purposes of comparison than any other method which we have tried. It is our belief that an index obtained in the fashion outlined gives a very delicate measure for comparison of these small masses of tissue.

In the tables which include animals that have received transplants of hypophyses from donor rats, we have included certain additional data. It was assumed that the average weight of the rats would indicate, at least to some extent, the amount of hypophyseal tissue transplanted. It did not seem wise to weigh the individual hypophyses because of the added exposure to possible infections. It is not legitimate to assume that the volume or mass of the hypophysis will bear an accurate ratio to the total weight of the animal, but it seemed probable that there would be a sufficiently definite relationship for these

Fig. 5. Photograph of experimental animal No. 49-838 after fixation in Bouin. Note difference in size of ovaries. This was due to extreme distention of bursa on one side. ×2.

weights to be of some significance. We have also included the number of days transpiring between the spaying of the donor rats and the utilization of their hypophyses for transplants. As will be seen in the discussion of the experiments, this interval seems to be of considerable importance. In the animals of the earlier experimental series, which received injections of commercial extract of placenta, the units of estrin present in the placental extract were determined and are listed as total number of rat units received by the donor rat during the course of the experiment.

In Table I (see Figs. 1 and 6) we have presented a series of normal immature mice as a basic measurement for the effects produced in the various experimental groups of animals. In examining Table I, it is obvious that the average size of ovaries of normal immature mice, as indicated by the index, is less than 1. It is unnecessary at this point to describe in detail the histological characteristics of these ovaries, as the small immature follicles, moderate amount of stroma, small bursa, and uniform lack of vascular injection are perfectly well known. In Table II (see Figs. 2 and 7) the control experiments for the first series are given. There were fifteen of these animals in which the indices varied from .8 (which is the only animal in the entire group with an index below 1) to 7.2, with an average of 2.9. The size of the ovaries of the control animals have, in no single experiment, ever been less than the average for the series of normal animals. In other words, in all of the animals reported, in the control as well as in the experimental group, there is definite evidence of hypophyseal effect. Of the control animals only three had an index above four. These animals received hypophyses

Fig. 6. Fig. 7. Fig. 8.

Figs. 6 to 14. Photomicrographs of sections of ovaries. The largest section was selected in each case in order to give some comparison in size. This comparison, however, cannot be considered as exact, because in some instances the largest dimension of the ovary was perpendicular to the axis of sectioning. For an exact comparison of size the index must be used. All are magnified 24 times.

Fig. 6. Photomicrograph of section of ovary from normal mouse No. 70–923.

Fig. 7. Photomicrograph of section of ovary from control mouse No. 39–790.

Fig. 8. Photomicrograph of section of ovary of experimental mouse No. 19–701.

from rats whose weights averaged 138 grams. There was in the group of donor rats no variation of very marked character and nothing which could account for the fact that three of the controls were markedly out of line in regard to the index. As a matter of fact, the donor rats for mouse 22 averaged 131 grams in weight, which was very close to the average weight of the entire group. Twenty-one days was the average length of time which elapsed between the date of spaying and the transplantation of the hypophyses. The maximum variation was 3 days, which cannot be considered of great importance.

There were 25 experimental animals in the first series (see Figs. 3, 4, 5, 8, and 9); these are included in Table III. We have divided these animals into sub-tables (A, B, C, D, E) in terms of the batch of material used for injecting the donor rats. This has been done because careful study of the data indicates that a greater similarity exists between members of these different groups than between the members of dissimilar groups. In other words it is probable that the amount of the particular stimulating substance concerned in the effects described varied considerably from batch to batch; the estrin content, however, remained remarkably constant.

In considering the experimental animals of this earlier group, certain factors become very

TABLE III A.—FIRST SERIES. PLACENTAL EXTRACT. BATCH I

Number	Units	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
19–701	53	12	2.4 x 2.2 x 3.6	19.0	101	19
20–702	53	12	1.5 x 2.2 x 2.7	8.9	116	19
21–703	54	12	1.4 x 2.2 x 2.2	6.8	120	19
			Average	11.9	112	19

TABLE III B.—FIRST SERIES. PLACENTAL EXTRACT. BATCH II

Number	Units	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
28–777	54	10	1.2 x 1.5 x 2.0	3.6	120	15
29–778	80	10	1.6 x 1.8 x 1.5	4.3	115	15
30–776	80	10	1.2 x 1.6 x 1.7	3.3	100	15
31–780	70	10	1.6 x 2.4 x 1.5	5.8	108	15
32–781	70	10	1.1 x 1.5 x 1.5	2.5	102	15
34–783	70	10	1.0 x 2.7 x 2.0	5.4	129	17
35–784	70	10	1.8 x 2.1 x 2.1	7.0	130	17
			1.3 x 1.9 x 2.5			
36–787	70	10	1.7 x 2.0 x 2.0	6.8	148	19
37–788	70	10	1.2 x 1.7 x 1.9	3.9	138	19
			Average	4.7	121	16

TABLE III C.—FIRST SERIES. PLACENTAL EXTRACT. BATCH III

Number	Units	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days spay
46–835	134	8	2.2 x 2.3 x 3.3	16.7	194	1
47–836	134	8	1.4 x 2.2 x 1.4	4.3	195	1
48–837	134	8	1.7 x 1.8 x 2.2	6.7	179	1
49–838	134	8½	1.7 x 2.0 x 3.8	12.9	166	1
50–839	134	8	1.5 x 2.3 x 2.3	8.0	171	1
			Average	9.7	181	1

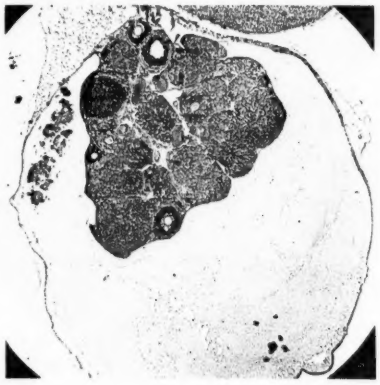

Fig. 9.

Fig. 10.

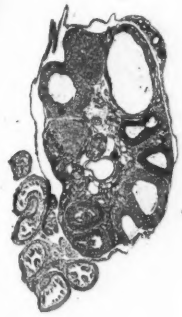

Fig. 11.

Fig. 9. Photomicrograph of section of ovary of experimental mouse No. 49–838. Note the large bursa.

Fig. 10. Section of ovary control mouse 15, second series.

Fig. 11. Photomicrograph of section of ovary of experimental mouse No. 2, second series (ether extract was used in this experiment).

clear. In the first place, there was a wide variation in the size of the ovaries obtained; the smallest ovary in this series had an index of 2.5 and the largest ovary an index of 19. Such a variation as this would be remarkable in experiments of a more standardized character, but the number of factors involved in this experiment was so great that any specific control was almost impossible. Of the factors which we are capable of recognizing, some of them have been controlled by the nature of the experiment. It is known, for example, that castration augments the capacity of the hypophysis to affect the ovary. We are not aware of any investigations which have accurately determined differences in the effect produced following variations in the period between castration and the implantation of the hypophyseal tissue into other animals; however, the difference in this group of experiments could not possibly have been due to variations in the time. The largest ovaries were not invariably from mice whose rat donors had been spayed over the longest period of time, although there is a slight tendency toward an increase in size incident to greater length of intervals. Experiments 19, 20, 21, 36, and 37 had 19 day intervals: in these experiments the average index was 9.1. Experiments 28, 29, 30, 31, and 32 all had 15 day intervals; in these animals the average index was 3.9. On the other hand, the intervals in the remainder of the experiments were 16, 17 or 18 days and the indices in these experiments varied over a wide range (2.5 to 16.7). It would seem legitimate, therefore, to conclude that the time between castration and implantation was a factor but that the difference of 2 or 3 days (the maximum difference in these experiments) was insufficient to explain all of the changes noted.

TABLE III D.—FIRST SERIES.
PLACENTAL EXTRACT. BATCH IV

Number	Units	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
54–879	138	8	1.5 x 2.2 x 1.7	5.6	144	17
55–880	138	8	1.9 x 1.5 x 2.1	6.0	154	17
57–882	138	8	2.5 x 1.9 x 2.7	12.8	144	17
			Average	8.1	147	17

TABLE III E.—FIRST SERIES
PLACENTAL EXTRACT. BATCH V

Number	Units	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
61–914	138	8¼	1.4 x 2.3 x 1.2 1.4 x 1.9 x 2.2	4.8	127	19
62–915	138	8	1.5 x 1.5 x 1.5	5.4	136	19
63–916	138	8½	1.9 x 2.2 x 1.7	7.1	129	19
64–918	138	9¼	1.1 x 2.3 x 1.8	4.5	140	19
65–918	138	9¼	1.3 x 2.5 x 1.3	4.2	134	19
			Average	4.8	133	19

TABLE III F.—FIRST SERIES. AVERAGES

	Index	Average wt. rat	Days prev. spayed
Averages from Table III A	11.9	112	19
Averages from Table III B	4.7	121	16
Averages from Table III C	9.7	181	17
Averages from Table III D	8.1	147	17
Averages from Table III E	4.8	133	19
Average	7.8	139	18

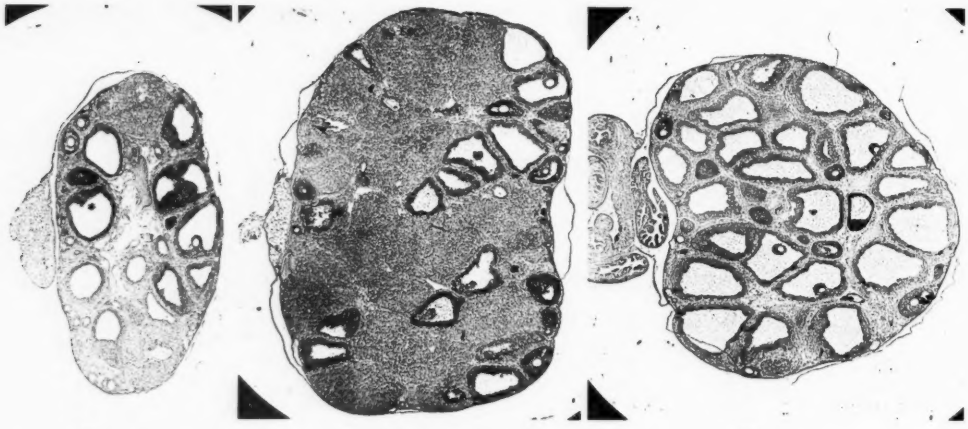

Fig. 12. Fig. 13. Fig. 14.

Fig. 12. Photomicrograph of section of ovary of mouse No. 11, second series (alcohol extract).

Fig. 13. Photomicrograph of section of ovary of mouse No. 18, second series (crude extract was used here).

Fig. 14. Photomicrograph of section of ovary of mouse No. 20, second series (crude extract).

The amounts of hypophyseal tissue which were implanted could of course easily be a factor of importance. The hypophyses were not weighed or measured individually, but the relation of the weight of the donor rats to the amount of change observed in the recipient mice was noted. We may assume that those animals showing an index above 10 could be considered as a maximum group. There were 4 of these animals, showing an average index of 15; the average weight of the donor rats of these animals was 150 grams. In the next group, animals showing indices between 7 and 10, the weight of the donor rats was found to be 104 grams. Grouping together all the animals having indices smaller than 7, the average weight was found to be 130 grams. The larger indices were, therefore, definitely connected with the heavier animals, but the ratio of increase n the weight of the rats is exceedingly small as compared with the ratio of increase in the size of the ovaries of the mice. Furthermore, there are many individual exceptions to this average, as, for example, experiment 19, which had the largest index, but which had next to the lowest rat weight (101 grams) as its factor; while experiment 46, with an index of 16.7, which is the next largest index in the group, had 194 grams as an average weight of rat donors.

The pelvic viscera (with the exception of the ovaries) from these animals were relatively uniform histologically. The uteri and tubes invariably showed marked effects of hypophyseal stimulation. The uterine epithelium was tall, showed many mitoses and some tendency toward pseudostratification. The ovaries were more variable; in many there were large masses of lutein tissue and many clearly defined corpora. There were also many large follicles, of which a considerable proportion contained blood. An effort was made to correlate the amount of lutein tissue with the number of enlarged follicles; this was not found to be possible, in that the ratio of corpora lutea to follicles varied enormously. In some ovaries there was a predominance of corpora lutea, and in others of follicles; in general, the impression was gained that individual masses of lutein tissue predominated slightly over the total number of follicles. It was interesting to note, however, that in none of the ovaries was there an approximately equal increase in follicles and corpora lutea. Either the corpora lutea or the follicles definitely predominated. The blood vessels were markedly injected in every case and in many instances the bursæ were markedly distended with fluid (Figs. 3 and 9). In a few instances blood was seen in these distended bursæ. Ov

were found in the tubes in considerable numbers and were also seen embedded in masses of lutein tissue and in blood filled follicles. There was no particular correlation found between the size of the ovary and the relative amounts of lutein tissue and follicles. One of the largest ovaries obtained consisted almost entirely of lutein tissue, while another of the larger ovaries consisted largely of graafian follicles. This was found to be equally true of those ovaries having smaller indices. After consideration of the results obtained in this group of experiments, it does not seem possible to determine any specific liberation of a particular hormone by the hypophysis.

SECOND SERIES OF EXPERIMENTS

When it became obvious from the studies of Leonard, Meyer, and Hisaw that estrin could not be the factor involved in our experiments, it seemed advisable to repeat them, in order to determine whether there could have been some error in our procedure or whether the agent causing the changes observed could be some other placental factor. It was considered as more important to obtain a definite separation of the estrus producing hormone than to attempt to isolate all three of Collip's fractions, inasmuch as we had no assurance as to which of these (or perhaps some other substance) might be the specific material involved in producing the results already described. It was our object to control our original experiments in a single series of new experiments and to determine, in addition, if, by this method, we could obtain a depression of the ovary stimulating capacity of the hypophysis by estrin, similar to that found by Leonard, Meyer, and Hisaw. These experiments have accomplished both purposes. We found that animals injected with the fraction containing estrin showed less ovary stimulating material in their hypophyses than did control animals, and also that the alcoholic extract contained some substance or substances which markedly increases the capacity of the hypophysis to stimulate the ovary.

These experiments have been carried out by one of us (Klingler) and, because of certain difficulties, have differed in minor ways from the original series in the manner of their execution. The donor rats were much larger and the interval between spaying and transplanting was longer than in our original experiments. It is, therefore, impossible to compare quantitatively the results obtained with those of the earlier group.

All of the extracts used were prepared from fresh human placentæ. The method of preparation consisted of repeated extractions in 95 per cent alcohol of finely pulped placenta under reduced pressure, at room temperature and in an acid medium. Following each addition of alcohol, the material was filtered. Ten volumes of alcohol were used with each extraction; the material was then concentrated and all the alcohol removed. The remaining material constituted our crude extract. In preparing the extract containing estrin, enough distilled water was added to the crude extract to permit of extraction of the lipoids by ether. The ether soluble material contained the estrin, and the remaining extract contained the alcohol soluble material. Ether extraction was repeated eight times, following which all of the ether was removed under reduced pressure at room temperature.

Sixty adult female rats were spayed and about 3 weeks following the operation were divided into four groups; one group received crude extract, one the ether extract containing estrin, one the alcohol soluble fraction, and one group was used as a control (spayed but not injected). The injections were made subcutaneously twice daily for 6 days, at the end of which time the animals were killed and their hypophyses, in the intact state, were implanted subcutaneously into infantile female mice. Each mouse received two hypophyses. These were implanted on successive days. The mice were sacrificed on the fourth day and their genital organs examined. The vaginas were open in each case and the uteri were enlarged, reddened, and injected.

In considering the averages presented in Tables IV, V, VI, and VII, one sees that the indices of the entire group of animals included in the second series are larger than those in the first series. This increase is proportionately larger throughout the group, and can be clearly demonstrated by comparing the 2.9

TABLE IV.—SECOND SERIES. CONTROLS

Number	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
12	8	1.8 x 1.6 x 2.8 2.4 x 1.4 x 2.1	7.5	255	31
13	8	2.3 x 2.1 x 1.6	7.7	255	31
14	8	1.5 x 1.5 x 1.7 1.8 x 1.6 x 1.3	3.8	260	31
15	8	1.8 x 1.8 x 1.4 1.8 x 1.3 x 2.0	4.6	250	31
		Average	5.9	255	31

TABLE V.—SECOND SERIES. ETHER EXTRACT

Number	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
1	8	1.3 x 2.2 x 1.7	4.8	270	25
2	8	1.3 x 2.4 x 1.3	4.1	270	25
3	8	1.5 x 1.8 x 1.3 1.6 x 1.6 x 1.0	3.0	270	25
4	8	1.5 x 2.1 x 1.3	4.0	275	25
5	8	0.9 x 1.4 x 2.2	2.7	275	25
		Average	3.7	272	25

average shown in Table II, with the 5.9 shown in Table IV, and the 7.8 average of Table III F to the 15.8 average of Table VII. In examining these differences, we are forced to interpret them as probably resulting from two factors: (1) the greater average weight of the rats used as donors and (2) the longer period of time transpiring between the date of castration and the time at which the rats were sacrificed. In examining these experiments somewhat more in detail, it is interesting to note that the indices of the control series were considerably larger than those of the animals which had received the ether extract (estrin). One might be inclined to presume that the difference of 6 days in the interval between spaying and implantation would be in favor of a smaller size of ovary in the ether extract group. But this should be compensated for, at least in part, by the slightly greater average weight of the rat donors. We should, therefore, be able to assume that the control series is adequate in this connection and that the actual difference in ovary index between 5.9 and 3.7 represents the specific inhibitory effect which was produced upon the anterior hypophysis by the injection of estrin (ether extract). These results are in accord with the findings of Leonard, Meyer and Hisaw, and Kunde, d'Amour, Gustavson and Carlson.

The ovaries of the control animals contained corpora lutea and follicles in about equal proportions. Some of the follicles were quite large, and a few contained blood. The ovaries of the animals which received the ether extract contained a few corpora lutea, a few blood filled follicles, and a larger number of follicles which did not contain blood. The latter varied considerably in size, some being quite large (Fig. 11). In Table VI we have listed the five animals which received the alcoholic extract. These 5 animals showed an average index of 6.9, with extremes of 3.3 and 9.6. These indices are somewhat larger than those of the controls, but not so markedly so as was found in the original series of experiments, with which they cannot, however, be directly compared. On the other hand, when compared with the animals tabulated in Table V (ether extract), it is seen that the average index is almost double, which obviously indicates a marked divergence in the effects produced by the ether and alcoholic extracts. The histological changes in the ovaries of the animals which had been given the alcoholic extract consisted of an increase in both corpora lutea and follicles, the latter slightly predominating. The follicles were moderate in size and comparatively regular. A few were filled with blood. The corpora lutea were usually distinctly outlined.

TABLE VI.—SECOND SERIES. ALCOHOLIC EXTRACT

Number	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
6	8	1.9 x 2.0 x 2.8 2.0 x 2.1 x 2.0	9.6	260	29
7	8	1.7 x 1.8 x 1.6 1.7 x 1.8 x 1.7	5.0	257	29
8	8	1.3 x 1.5 x 1.7 1.1 x 2.0 x 1.5	3.3	258	29
9	8	1.8 x 2.6 x 2.0 2.6 x 1.7 x 2.2	9.5	255	29
10	8	1.6 x 2.0 x 2.4 2.0 x 2.6 x 1.3	7.3	243	29
		Average	6.9	255	29

TABLE VII.—SECOND SERIES. CRUDE EXTRACT

Number	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
16	8	4.3 x 2.1 x 2.9 3.3 x 2.8 x 2.6	24.9	240	35
17	8	3.4 x 2.0 x 2.2 3.0 x 2.2 x 2.0	14.0	250	35
18	8	2.8 x 2.1 x 2.4 2.4 x 2.1 x 3.3	15.3	250	35
19	8	2.2 x 2.4 x 2.2 2.5 x 1.7 x 2.6	11.2	250	35
20	8	2.4 x 1.8 x 2.6 2.6 x 2.4 x 2.6	13.7	247	35
		Average	15.8	247	35

When one considers the five animals included in Table VII, which received transplants from rats previously injected with the crude extract, it is obvious that a more marked

effect was produced. It is possible that this exaggerated effect was in part due to the slightly increased period between the spaying of the rats and the implantation of the hypophyses. It does not seem probable, however, that this factor could account for the tremendous increase which was found. The differences between the animals injected with the alcoholic and crude extracts must have been due to a failure to remove all of the active substance by our chemical extraction or to some synergistic action of the substances present in the crude extract. Further experiments are under way at the present time, with improved methods of extraction, to determine which of these possible explanations can be definitely substantiated. These experiments are not, however, needed to establish the primary point of the presence in the placenta of some substance which increases the capacity of the anterior hypophysis to stimulate the ovary.

The ovaries of the animals of the crude extract group differed markedly from all the others of the second series. In 4 of the animals there was a marked predominance of lutein tissue some of which was in discrete masses, while some was more diffuse and suggested luteinization of unruptured follicles. The fifth animal (No. 20) showed a very large number of follicles which were quite even in size and most of which did not contain blood (Fig. 14). In mouse No. 16 one ovary consisted almost entirely of lutein tissue, while the other had about the same number of follicles as corpora lutea. In animals Nos. 17 and 19 there was a marked predominance of lutein tissue, there being at least three or four times as many corpora as there were follicles. In animal No. 18 the number of corpora lutea was about double that of follicles. In general, therefore, it is clear that the amount of lutein tissue predominated over the number of follicles, except in the one of the five experiments, in which there was an almost complete absence of corpora.

DEDUCTIONS

The experiments outlined have clearly demonstrated that the ovary stimulating properties of the anterior hypophysis can be increased by a placental extract, which probably contained all three of Collip's fractions, while estrin, one of the components of the crude extract, definitely depresses the hypophysis. It is obvious that the stimulation may be the effect of the anterior pituitary-like substance alone or it may be the effect of emmenin and estrin in combination with each other, or in combination with the anterior pituitary-like substance. There is, of course, always a possibility that the effect observed was produced by some entirely new substance, although this seems unlikely, and it is not at present considered necessary to explain our results. The possibility that there are, in the placenta, two substances having a diametrically opposite action on the anterior lobe raises the question of a possible balance of these opposing forces under normal conditions. The proper understanding of this balance is full of interesting possibilities.

One must also consider the question of the reaction shown by these experiments in terms of the normal animal. The removal of the ovaries was carried out in order to eliminate the estral cycle and thereby standardize the animals, but it is entirely possible that the presence of these organs intact may furnish some additional mechanism which would modify the effects of these extracts on the hypophysis. One fact which must be remembered is that, in spayed animals, there is a storage of secretion in the hypophysis which does not take place in the normal animal. It is entirely possible that, in our experiments, modification of this mechanism has been produced.

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THE FALLACY OF CHEMICAL STERILIZATION OF SURGICAL CATGUT SUTURES

With Particular Reference to the Use of Copper Salts, Peppermint Oil, and Mercury

RALPH OAKLEY CLOCK, M.D., F.A.C.P., New York

THERE are two principal methods in use today for subjecting catgut sutures to sterilization: one is with heat, and the other is with chemicals. The primary object of this research work was to determine whether any of the chemical compounds, which are on the market or which are otherwise available, will exhibit reliable and effective bactericidal properties when used for sterilizing surgical catgut. Efficient germicidal action is claimed or has been demonstrated for many chemical compounds when used for various surgical, medical, or laboratory purposes. Hence, the initial studies in this investigation were confined to the sterilizing action of such compounds on catgut; but as the work progressed, many other chemical compounds were included in the study.

Contaminated commercial catgut sutures. The chemical method of sterilization has been given, probably, a more extensive trial in Germany than elsewhere. And yet, Knorr found in his investigations, during a 4 year period of bacteriological examination of original packages of catgut obtained from commercial sources, or from clinics, or from physicians, that at least 80 per cent did not meet the officially established requirements for sterility, both pathogenic and non-pathogenic bacteria being found in the sutures. In England, Bulloch purchased and examined bacteriologically 77 sutures manufactured by 8 different makers. Of these, he found 58 sutures, or more than 75 per cent, to be infected with living bacteria. In this country, Meleney and Chatfield made a 3 year study of the sterility of catgut sutures obtained from surgical clinics or purchased from the open market throughout the country. They found that 12.5 per cent of 174 sutures examined were contaminated with spore-bearing bacteria. Sutures from 10 manufacturers yielded no growth, while the products of 7 firms showed bacterial growth ranging from 5 per cent to 67 per cent of specimens tested.

Chemicals previously used. The chemical compounds which have been used in an attempt to destroy the bacteria commonly present in raw catgut are almost legion. In his investigations Mackie tried out various strengths of alcohol, glycerol, chloroform, oil of cloves, oil of eucalyptus, phenol, lysol, formalin, acriflavine, brilliant green, crystal violet, biniodide of mercury, perchloride of mercury and silver nitrate, but found them lacking in true germicidal properties so far as catgut was concerned. In his review of the disinfecting power of numerous chemicals, Bulloch found that phenol, perchloride of mercury, biniodide of mercury, silver compounds, oil of juniper, oil of turpentine, oil of lavender, oil of cajeput, oil of eucalyptus, formalin, picric acid, hypochlorites, chlorin water, bromine, pyoktanin, methyl blue, eosin, acriflavine, tannic acid, lysol, tellurium, sulphur dioxide, alcohols, ether, chloroform, acetone, and benzine were inefficient as sterilizing agents for catgut.

Present researches on chemical sterilization. During the past 2½ years, I have made an intensive study of the possibility of effectively sterilizing catgut by means of chemical treatment. In this investigation, I tried out a great many chemical substances, including mercurochrome, mercurophen, merthiolate, metaphen, potassium-mercuric-iodide, hexylresorcinol, tribromresorcinol, orthophenylphenate, ethylhydrocuprene, tribrombetanaphthal, copper cyanide, copper chloride, copper sulphate, copper sulphate plus methylene blue, zinc sulphate, peppermint oil, oil of tea tree (Melaleuca alternifolia), hydrogen peroxide, malachite green, pyridium, iodine, iodine plus potassium iodide, myodine, parachlormetacresol, diacetoxymercurioorthocresol, parachlorphenol, and chlorthymol ester.

Several thousand sutures, treated with various strengths and combinations of these

chemicals, were prepared under various conditions as regards duration of the chemical sterilization treatment, the hydrogen-ion concentration and temperature of the solutions, etc.; the chemical sterilization treatments being applied to catgut ribbons, to raw catgut strings, as well as to catgut artificially infected with a sporulating culture. For controls, duplicate lots of the chemically sterilized sutures were subjected to heat sterilization. The finished sutures were tested bacteriologically by the method of Meleney and Chatfield (10).

In searching the literature relating to the sterilization of catgut, I found that rather broad claims are made for copper sulphate and peppermint oil as sterilizing agents for catgut. I also found that these chemical agents are being used for the sterilization of catgut sutures which are claimed to be sterile and which are being used on an extensive scale. Hence, it seemed desirable to conduct sufficient experiments with these particular chemicals to check up the claims made for them; and to prove or disprove the reliability, practicability, and efficiency of these chemicals as sterilizing agents for catgut.

No such claims, however, were found for mercury compounds. But since wide publicity has been given to claims for the germicidal action of some of the mercury compounds now on the market, and in view of the fact that many experiments have been published showing that these compounds exhibit true germicidal action when used for laboratory, surgical, or medical purposes, I devoted considerable study to the sterilizing action of these mercury compounds on catgut sutures.

Mechanism of disinfection. Although several theories have been advanced to explain the mechanism of disinfection, the investigations of Bancroft and Richter have demonstrated that all types of chemical disinfectants affect bacteria in the same manner—by coagulating the colloids of the cell. The coagulation depends upon the absorption by the colloids of sufficient ions of the chemical substance. Furthermore, they have shown that this coagulation may be of two types: (1) reversible coagulation which inhibits the activity of bacteria but does not kill them (bacteriostatic action or antisepsis); and (2) irreversible coagulation which is responsible for the death of the bacteria (bactericidal action or disinfection).

Copperized catgut in Germany. At the University of Bonn in Germany, von Linden conducted some experiments with catgut sutures by saturating them with copper salts. She claimed that such treatment would completely sterilize the sutures, destroying not only staphylococci but also tetanus spores; and that sutures thus treated would keep sterile for weeks, even when left exposed to air and dust. In the Municipal Clinic for Women in Stuttgart, Germany, copperized catgut prepared by the von Linden method has been used for one and one-half years by Baisch, who reports that the antiseptic action of copperized catgut has been fully demonstrated by exhaustive bacteriological investigation, and that copperized catgut undoubtedly kills not only the pus cocci but also tetanus spores.

Copperized catgut in United States. Early in 1931, while examining sutures of various manufacturers, I found upon chemical analyses that the catgut sutures of three manufacturers in the United States contained appreciable quantities of copper. Bacteriological examination of these sutures by the Meleney and Chatfield (10) method indicated entire absence of growth.

In spite of the fact that von Linden and Baisch reported that the bactericidal action of copper salts for catgut had been fully demonstrated, I was not convinced that the American-made copperized catgut sutures which I examined by the Meleney and Chatfield method were in any sense sterile; because I found that their neutralizing solution of 1 per cent sodium thiosulphate and 1 per cent sodium carbonate did not remove the copper salts from the sutures.

Neutralizing fluid for copper. Accordingly, various chemical neutralizing solutions were prepared and a study was made of their power of removing copper salts from catgut. Finally, after using many chemical solutions and making many tests, I found that the copper salts can be entirely dissolved and removed from the catgut by using a special neutralizing solution consisting of 5 per cent ammonium chloride with ½ per cent ammonium hydroxide. The nature of the chemical reaction involves

the formation of a double salt of ammonia and copper which is water soluble. Repeated chemical analyses of copperized catgut, before and after treatment with this neutralizing solution, have demonstrated that the catgut sutures can be entirely freed of copper salts. The next step in this research study was thus apparent: namely, to subject copperized catgut to bacteriological tests in which this special neutralizing solution would be employed to remove the copper salts.

Bacteriological technique. Therefore, catgut ribbons made from fresh sheep intestines under ideal sanitary conditions were subjected to the sterilizing action of copper salts after the method recommended by von Linden (6). The copperized catgut ribbons were then made into finished sutures which were tubed in ethyl alcohol. Chemical analyses of these sutures showed appreciable quantities of copper present. In applying bacteriological tests, the sutures were first transferred aseptically to tubes of sterile ammonium chloride with ammonium hydroxide and incubated 24 hours. Then they were again aseptically transferred to tubes of this sterile, special neutralizing solution and again incubated 24 hours; so that the sutures thus received two treatments in the ammonium chloride and ammonium hydroxide solution. Then the procedure adopted by Meleney and Chatfield (10) was followed, wherein the sutures were transferred under aseptic technique into sterile distilled water and incubated 24 hours; and then into tubes containing a sterile solution of 1 per cent sodium thiosulphate and 1 per cent sodium carbonate and incubated 24 hours. Finally, the sutures were transferred aseptically into tubes of sterile Novy (11) culture medium. Those tubes which were incubated anaerobically were closed with a "vaspar" seal, as used and recommended by Hall. All culture medium tubes were incubated 15 days, as recommended by Meleney and Chatfield (10).

Controls. A complete set of controls is essential if the bacteriological test is to prove efficient and reliable. Meleney and Chatfield attempted to surround their standard test with every precaution; and the controls which they specified are both important and necessary. However, in addition to the controls which they described, I have demonstrated that other controls are required if the test is to be adequately safeguarded. In applying the standard bacteriological test to the various lots of sutures examined throughout this entire investigation, I used the following three additional controls which I think are essential: (1) Aerobic and anaerobic tubes of culture medium were planted with 10 cubic centimeters of each lot of distilled water and incubated 15 days to determine sterility of the water. (2) Aerobic and anaerobic tubes of culture medium were planted with 10 cubic centimeters of each lot of the neutralizing solutions and incubated 15 days to determine sterility of the solutions. (3) Two tubes of culture medium, not planted with catgut, but sealed with a layer 2 centimeters thick from every batch made of the "vaspar" mixture were incubated 15 days to determine sterility of the anaerobic seal.

TABLE I.—COPPERIZED CATGUT

Prepared by von Linden's process

Series No.	Aerobic tests			Anaerobic tests		
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6
153	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 24 hrs.
155	O	O	O	G 48 hrs.	G 6 days	O
156	O	O	O	G 13 days	O	O

Explanatory. G indicates bacterial growth, followed by the number of hours or days of the incubation period that elapsed before growth appeared. O means that there was entire absence of growth in the tube at end of 15 days' incubation.

Series 153 consisted of control sutures not sterilized by heat nor with any chemical. Series 155 and 156 were treated with copper salts. In testing these sutures bacteriologically, copper salts were first removed from the sutures by means of a special neutralizing fluid of ammonium chloride and ammonium hydroxide; and then the sutures were put through the standard Meleney and Chatfield test.

The bacteriological tests on copperized catgut sutures brought to light both aerobic and anaerobic bacterial growth; the anaerobic growth appearing as late as the thirteenth day, as indicated in Table I.

Artificially infected copperized catgut. The catgut, from which the sutures used in the foregoing experiment were made, represented the usual run of fresh sheep intestines from the abattoir. Therefore, in order definitely to determine the antibacterial action of copper salts, catgut ribbons were artificially infected

TABLE II.—ARTIFICIALLY INFECTED COPPERIZED CATGUT

Raw catgut artificially infected with sporulating culture and treated with copper salts by von Linden's process

Series No.	Aerobic tests			Anaerobic tests		
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6
191	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.
196	O	O	O	O	O	O
197	O	O	O	G 3 days	G 6 days	G 6 days

Explanatory. G indicates bacterial growth, followed by the number of hours or days of the incubation period that elapsed before growth appeared. O means that there was entire absence of growth in the tube at end of 15 days' incubation.

Series 191 consisted of control sutures not sterilized by heat nor with any chemical, but artificially infected with spores.

Series 196, although artificially infected with spores and treated with copper salts, showed entire absence of growth after test by the standard Meleney and Chatfield method; the neutralizing solution of 1 per cent sodium thiosulphate and sodium carbonate being used.

Series 197 was treated with the special neutralizing fluid of ammonium chloride and ammonium hydroxide to remove the copper salts, in connection with the standard Meleney and Chatfield bacteriological technique. Anaerobic growth proves that copper salts exert a bacteriostatic action and not a true germicidal action.

with a sporulating culture of Bacillus subtilis and Bacillus sporogenes. Some of these ribbons were not treated with any chemical but were immediately made into sutures for controls and tubed in ethyl alcohol. These control sutures were tested by the standard bacteriological method (10). The remaining infected ribbons were treated with copper salts according to von Linden's process and made into finished sutures which were tubed in ethyl alcohol. These artificially infected, copperized sutures were divided into two lots: one of which was tested by the standard bacteriological method of Meleney and Chatfield, using their neutralizing solution of sodium thiosulphate and sodium carbonate; while the other lot was treated with the special neutralizing fluid of sterile ammonium chloride and ammonium hydroxide to remove the copper salts, and then was put through the standard bacteriological test (10). All of the control sutures (artificially infected but not treated with copper salts) promptly showed bacterial growth. All of the artificially infected copperized sutures tested by the standard method (10) and with the standard neutralizing fluid showed entire absence of growth; but the lot of artificially infected copperized sutures that was treated with the special neutralizing fluid and then was put through the standard bacteriological technique (10) showed *anaerobic bacterial growth*, as indicated in Table II.

This experiment demonstrates that *copper salts do not sterilize catgut*, but merely arrest bacterial growth through bacteriostatic action. It also proves that sodium thiosulphate and sodium carbonate will not remove copper salts from catgut, and that if this solution be used as the sole neutralizing fluid, falsely negative results will be obtained.

Commercial copperized catgut sutures. From the open market, I again purchased catgut sutures of the three American manufacturers whose products on previous analyses had been shown to contain copper salts. When analyzed chemically, the product of manufacturer A was found to contain 0.34 per cent copper; that of manufacturer B contained 0.75 per cent copper; while the sutures of manufacturer C contained 1.23 per cent copper. The tubing fluids used by these manufacturers consisted of alcohol denatured with a mercury compound. After removing the copper salts under aseptic technique with sterile ammonium chloride and ammonium hydroxide, the sutures were subjected to the standard bacteriological test of Meleney and Chatfield. One hundred and fifty-six copperized catgut sutures from these three manufacturers were tested, and 42 of them were found to contain living bacteria of the aerobic and anaerobic types. Thus, approximately 27 per cent of these copperized catgut sutures were nonsterile, as indicated in Table III.

Von Linden's copperized catgut was purchased from manufacturer D in Germany; and, when analyzed chemically, the sutures were found to contain approximately 3 per cent copper. After aseptically removing the copper salts by means of the ammonium chloride and ammonium hydroxide solution, the standard bacteriological test was applied. The results showed that 19 out of 36 (52 per cent) of the sutures contained living bacteria (see Table IV). These results confirm those obtained by Weichardt in the Erlangen Hygienic Institute as reported by Mehnert. Professor Weichardt believes that copperized catgut should be rejected because it lacks the

TABLE III.—COPPERIZED CATGUT SUTURES

American manufacturers, A, B, and C

Manufacturer	Aerobic tests						Anaerobic tests					
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6	Tube 7	Tube 8	Tube 9	Tube 10	Tube 11	Tube 12
A Lot 1	G 3 days	O	O	O	O	O	G 8 days	O	O	O	O	O
A Lot 2	O	O	O	O	O	O	G 8 days	O	O	O	O	O
B Lot 1	O	O	O	O	O	O	G 48 hrs.	G 8 days	O	O	O	O
B Lot 2	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 10 days	G 13 days	O	G 48 hrs.	G 4 days	G 8 days	G 8 days	O	O
B Lot 3	O	O	O	O	O	O	G 11 days	O	O	O	O	O
B Lot 4	G 15 days	O	O	O	O	O	G 11 days	G 13 days	O	O	O	O
B Lot 5	G 15 days	O	O	O	O	O	G 13 days	G 13 days	O	O	O	O
B Lot 6	G 3 days	O	O	O	O	O	G 9 days	G 13 days	G 13 days	O	O	O
B Lot 7	G 13 days	O	O	O	O	O	G 12 days	G 13 days	G 13 days	O	O	O
C Lot 1	G 48 hrs.	G 48 hrs.	G 48 hrs.	O	O	O	G 10 days	O	O	O	O	O
C Lot 2	G 7 days	O	O	O	O	O	G 7 days	G 12 days	G 13 days	G 13 days	O	O
C Lot 3	O	O	O	O	O	O	G 13 days	G 13 days	O	O	O	O
C Lot 4	O	O	O	O	O	O	G 4 days	G 7 days	O	O	O	O

Explanatory. G indicates bacterial growth, followed by the number of hours' or days' incubation that elapsed before growth appeared. O means entire absence of growth in the tube at end of 15 days' incubation.

All sutures were treated with the special neutralizing fluid of ammonium chloride and ammonium hydroxide to remove copper salts as a preliminary step to the standard Meleney and Chatfield bacteriological method.

important quality of sterility, and my views coincide with his on this subject.

Bacteriostatic action of copper. Vignati and Schnabel have shown that copper salts act on bacteria by coagulating the bacterial colloids; an action similar to that on serum colloids. These investigators have demonstrated that copper salts, when added to a broth culture of Bacillus coli, constitute a mechanical obstacle to bacterial activity in that the chemical compound isolates the bacteria from their surroundings and deprives them of nutritional support; thus preventing their multiplication. They have also shown that the bacteria may be reactivated by means of a neutralizing solution capable of re-dissolving the copper coagulum, which is thus proved to be directly reversible.

From a study of the results of my researches on copperized catgut described in this paper, it is evident that when catgut sutures are treated with copper salts, an arrested development of the bacteria within the catgut is brought about through the bacteriostatic action of the copper. Apparently, the copper salts act on the bacterial colloids in such a manner that, even in the presence of a suitable culture medium, the bacteria are deprived of their nutritional support. It is equally evident from my experiments that the removal of the copper salts from the catgut, by means of an effective neutralizing fluid consisting of ammonium chloride and ammonium hydroxide, reactivates the bacteria; so that, when nutritional support is provided in the form of a proper culture medium, bacterial growth occurs.

Reaction of tissues to copperized catgut. While the above bacteriological tests on copperized catgut were in progress, some plain

TABLE IV.—COPPERIZED CATGUT SUTURES

Made in Germany

Manufacturer	Aerobic tests						Anaerobic tests					
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6	Tube 7	Tube 8	Tube 9	Tube 10	Tube 11	Tube 12
D Lot 1	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 9 days	O	G 12 days	G 12 days	G 12 days	O	O	O
D Lot 2	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	O	O	G 12 days	G 12 days	O	O	O	O
D Lot 3	G 48 hrs.	G 48 hrs.	G 48 hrs.	O	O	O	G 11 days	G 11 days	O	O	O	O

Explanatory. G indicates bacterial growth, followed by the number of hours' or days' incubation that elapsed before growth appeared. O means entire absence of growth in the tube at end of 15 days' incubation.

All sutures were treated with the special neutralizing fluid of ammonium chloride and ammonium hydroxide to remove copper salts before being tested by the standard Meleney and Chatfield bacteriological method.

(untreated) catgut sutures sterilized by heat, and some of a similar size treated with copper salts after the method of von Linden and also subjected to heat sterilization, were embedded in animal tissues for the purpose of determining the relative degree of irritation produced in the tissues by the plain and by the copperized sutures. Both kinds of sutures were prepared from the same batch of raw catgut, in order to assure uniform raw material.

Each of these two kinds of sutures was woven through the serosal layer of a rabbit's stomach under aseptic technique. Four rabbits were used, and they were sacrificed at 5 day intervals. After noting the gross pathological appearance of the removed stomachs, illustrative pieces of tissue containing the suture were placed in 10 per cent formaldehyde and histological sections made and mounted on microscopic slides. Simple haematoxylin eosin stain, as well as the fibrous tissue differential stain of van Gieson, was used.

A study of the histological appearance of the tissues after the sutures had been embedded for 5 days, 10 days, 15 days, and 20 days, showed that the copperized catgut was less readily absorbed than the plain, untreated catgut sutures. Also, the copperized sutures were definitely more irritating, as indicated by the greater cellular response which they produced as compared to the plain untreated sutures.

Peppermint oil catgut sutures in England. A very novel and ingenious method adopted for the chemical sterilization of catgut sutures was reported by Porritt. In this method, the raw catgut is first soaked 6 hours in a solution of sodium bichromate, phenol, and glycerin; then dried and placed in hermetically closed containers filled with peppermint oil in ethyl alcohol (1:10). These containers are immersed in a water bath at 60 degrees C. for 2 hours, on 2 successive days. The sutures are then removed from the containers and preserved in 1:20 phenol in ethyl alcohol.

In order to demonstrate the efficiency of his method, Porritt artificially infected some raw catgut with Bacillus subtilis, Bacillus sporogenes, Bacillus tetanus, and Bacillus welchii; the infected sutures were then put through his peppermint oil process for chemical sterilization, and the peppermint oil and chromic acid were removed by distillation with ether and water in a sterile Soxhlet apparatus. For controls, another lot of catgut was similarly infected and then subjected to the distillation process; the sterilization process with peppermint oil being omitted. Both lots were then subjected to bacteriological tests (technique not described). He reports that all culture tubes containing the peppermint oil treated sutures showed entire absence of bacterial growth; while the tubes of the control sutures all contained a heavy growth of bacteria corresponding to the species used for artificially infecting the catgut.

Bacteriological tests of peppermint oil catgut. Owing to the fact that Porritt's peppermint oil catgut sutures are made and used exclusively in a British hospital, they are not for sale in the open market in England. However, I endeavored to secure some of these sutures direct from Mr. Porritt and to obtain

details of his bacteriological tests, but without success. Therefore, in order to test the value of peppermint oil as a sterilizing agent, catgut sutures were prepared under ideal sanitary conditions from the ordinary run of fresh sheep intestines at the abattoir, and sterilized by Porritt's complete peppermint oil process as outlined. The sutures were then tested bacteriologically by the standard method of Meleney and Chatfield. Five lots of controls were also tested, as follows: (a) In order to remove the possibility of all chemicals used in the peppermint oil process from acting as sterilizing agents, raw catgut was subjected to the peppermint oil process and then all chemicals were extracted with ether and water in a sterile Soxhlet apparatus; the catgut being placed in sterile thimbles. (b) To exclude phenol in the tubing fluid as the possible sterilizing agent, some raw catgut, not subjected to the peppermint oil or other treatment, was stored for 72 hours in 1:20 phenol in ethyl alcohol in hermetically sealed tubes. (c) To rule out the peppermint oil as the possible sterilizing agent, raw catgut, after being subjected to Porritt's peppermint oil process, was extracted with ether to remove the peppermint oil; the catgut sutures being placed in sterile thimbles and no tubing fluid used. (d) To exclude sodium bichromate as a possible sterilizing agent, raw catgut was soaked 6 hours in Porritt's solution of sodium bichromate, phenol, and glycerin, but no further treatment was given; the sutures being transferred aseptically from this solution to the bacteriological testing fluids. (e) As an additional control, raw catgut strings (untreated) were also tested.

The bacteriological tests were applied in accordance with the technique previously referred to as the standard method of Meleney and Chatfield. All culture tubes (aerobic as well as anaerobic) containing the peppermint oil treated sutures as well as those containing the controls (a, b, c, d, and e) showed bacterial growth within 48 hours; thereby demonstrating that catgut sutures prepared by the peppermint oil method of Porritt are non-sterile. This experiment was repeated with another lot of raw catgut, but the results were the same (see Table V).

TABLE V.—PEPPERMINT OIL CATGUT

Porritt's process

Series No.	Aerobic tests			Anaerobic tests		
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6
109 (a)	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 48 hrs.	G 48 hrs.
110 (b)	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 24 hrs.
111 (c)	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.
120 (d)	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.
121 (e)	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.
108	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.
128	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.

Explanatory. G indicates bacterial growth, followed by the number of hours' or days' incubation that elapsed before growth appeared.

Series 109, 110, 111, 120 and 121 are control lots and correspond to controls (a), (b), (c), (d) and (e) described in the text.

Series 108 and series 128 comprised sutures prepared from two different lots of raw catgut; and both series were sterilized by Porritt's process.

Sutures in all of these series were tested by the standard Meleney and Chatfield method.

Artificially infected peppermint oil catgut. While these results demonstrated that the peppermint oil process will not sterilize even the ordinary run of raw catgut, and the method is, therefore, inefficient and unsafe because the peppermint oil sutures contain living bacteria; yet it seemed advisable to prove conclusively the presence or absence of any germicidal properties of peppermint oil for catgut by treating some artificially infected catgut by the Porritt method. Accordingly, catgut ribbons were infected with a sporulating culture of Bacillus subtilis and Bacillus sporogenes. Then the ribbons were made into finished sutures which were divided into two lots; one of which was subjected to Porritt's peppermint oil process, while the other lot was left untreated for control. The results of bacteriological tests on the two lots are shown in Table VI; and *these results prove beyond all question that Porritt's method of chemically sterilizing catgut with peppermint oil is unsafe.*

Mercury compounds for sterilizing catgut. A large number of experiments was carried out by subjecting catgut ribbons, raw catgut strings, as well as artificially infected catgut, to chemical sterilization with the various mer-

TABLE VI.—ARTIFICIALLY INFECTED PEPPERMINT OIL CATGUT

Raw catgut artificially infected with sporulating culture and treated by Porritt's process

Series No.	Aerobic tests			Anaerobic tests		
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6
184	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.
185	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.

Explanatory. G indicates bacterial growth, followed by the number of hours' or days' incubation that elapsed before growth appeared.
Series 184 consisted of control sutures artificially infected but not treated with peppermint oil.
Series 185, after being artificially infected, was put through Porritt's process with peppermint oil.
All sutures were tested by the standard Meleney and Chatfield method.

cury compounds previously mentioned. The results of bacteriological tests of such chemically sterilized sutures showed, however, that none of these mercury compounds will effectively sterilize catgut.

During the year 1931, in connection with my study of mercury compounds, I purchased in the open market, at intervals of a few months, several lots of catgut sutures of American manufacturer E. Chemical analyses always revealed an appreciable amount of a mercury compound in the sutures; and my bacteriological examinations of this manufacturer's sutures showed the presence of living bacteria in at least 2 specimens from every batch of twelve sutures which I tested by the Meleney and Chatfield method These results were in conformity with those which I obtained when testing the experimental lots of sutures sterilized chemically with the various mercury compounds. However, chemical analyses of this manufacturer's sutures purchased early in 1932 showed them to be heavily impregnated with a mercury compound; and, when such sutures were examined bacteriologically by the standard test of Meleney and Chatfield, entire absence of bacterial growth was indicated.

Upon further investigation, I found that the amount of the mercury compound present in the sutures purchased in 1932 was so large (3.5 per cent) that the neutralizing fluid of 1 per cent sodium thiosulphate and 1 per cent sodium carbonate used in the standard Meleney and Chatfield test would not remove all of the mercury compound from the sutures. Accordingly, a 5 per cent solution of sodium thiosulphate was tried for this purpose; but it was found that even this strength would not remove all of the mercury compound from the sutures. Further research demonstrated that this could be attained by means of a neutralizing fluid consisting of *10 per cent solution of sodium thiosulphate.* Therefore, as the next logical procedure, some sutures of manufacturer E purchased in 1932 were tested bacteriologically by first transferring them aseptically to, and incubating them in, a sterile neutralizing solution of 10 per cent sodium thiosulphate for 24 hours; and then by putting them through the standard Meleney and Chatfield technique. *The results of these tests showed the presence of living bacteria in the sutures.*

Two additional lots of sutures of manufacturer E were purchased. One lot consisted of plain catgut sutures, while the other lot was chromic catgut. Chemical analyses of these sutures revealed the presence of a large amount of a mercury compound (mercuric iodide). Twelve sutures of each lot were examined bacteriologically by the standard Meleney and Chatfield method, and the results indicated entire absence of bacterial growth (see Table VII). *Twelve other sutures of these same lots and bearing the same batch numbers* were first transferred under aseptic conditions to, and incubated for 24 hours in, the neutralizing solution of 10 per cent sodium thiosulphate. Then these sutures were put through the standard bacteriological technique of Meleney and Chatfield, and *all twelve sutures of one lot (plain) and eight sutures of the other lot (chromic) were found to contain living bacteria* (see Table VIII). Hence, it is evident that the mercury compound present in such large amount in these sutures exerted a bacteriostatic action, thereby arresting development of the bacteria within the catgut. Likewise, it is apparent from these experiments that removal of all of the mercury compound from the sutures, by means of a neutralizing solution of 10 per cent sodium thiosulphate, reactivates the bacteria which are thus enabled to grow in the culture medium.

TABLE VII.—MERCURIALIZED CATGUT SUTURES

Tested by standard Meleney and Chatfield method

Manufacturer	Aerobic tests						Anaerobic tests					
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6	Tube 7	Tube 8	Tube 9	Tube 10	Tube 11	Tube 12
E Lot 1	O	O	O	O	O	O	O	O	O	O	O	O
E Lot 2	O	O	O	O	O	O	O	O	O	O	O	O

Explanatory. O means entire absence of growth in the tube at end of 15 days' incubation.
Sutures comprising Lot 1 were plain catgut; while those of Lot 2 were chromic catgut.
Chemical analyses showed that these sutures contained 3¼ per cent of mercury; also that all of the soluble mercury was not removed from the sutures by the neutralizing solution of 1 per cent sodium thiosulphate and 1 per cent sodium carbonate, used as part of the standard Meleney and Chatfield method.

TABLE VIII.—MERCURIALIZED CATGUT SUTURES

Tested by standard Meleney and Chatfield method, but a special neutralizing solution of 10 per cent sodium thiosulphate was used as a preliminary step

Manufacturer	Aerobic tests						Anaerobic tests					
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6	Tube 7	Tube 8	Tube 9	Tube 10	Tube 11	Tube 12
E Lot 1	G 4 days	G 4 days	G 4 days	G 5 days	G 12 days	G 13 days	G 7 days	G 9 days	G 12 days	G 13 days	G 13 days	G 13 days
E Lot 2	G 7 days	G 10 days	G 12 days	G 12 days	O	O	G 12 days	G 13 days	G 13 days	G 13 days	O	O

Explanatory. G indicates bacterial growth, followed by the number of hours' or days' incubation that elapsed before growth appeared. O means entire absence of growth in the tube at end of 15 days' incubation.
Sutures comprising Lot 1 were plain catgut; while those of Lot 2 were chromic catgut.
These sutures were taken from the same lots and bore the same batch numbers as the sutures used for the tests shown in Table VII.
Before being put through the standard Meleney and Chatfield technique, these sutures were transferred aseptically to tubes of sterile 10 per cent sodium thiosulphate and incubated for 24 hours to remove the large amount of mercury (3.5 per cent.)

These results serve to emphasize the fact that falsely negative findings may follow the use of the standard Meleney and Chatfield test unless a close check-up is always made: first, by subjecting some of the sutures under examination to careful chemical analyses to determine the nature and quantity of any chemical compound that may be present; and second, by using, in connection with the bacteriological tests, a suitable neutralizing fluid which will dissolve and remove whatever chemical compound is found to be present.

In order to detect the presence of bacteria in catgut which has been subjected to the chemical action of such large amounts of a mercury compound as are being used by American manufacturer E, the use of 10 per cent sodium thiosulphate for a neutralizing solution is recommended. This solution should be used as a preliminary step to the standard bacteriological technique of Meleney and Chatfield; so that the 10 per cent solution of sodium thiosulphate will be removed from the sutures by the distilled water which constitutes the first step of the standard Meleney and Chatfield method, and thus will not be carried over into the culture medium where it might inhibit bacterial growth.

Other chemical compounds for sterilizing catgut. The sterilizing action of each of the other chemical compounds included in this study was systematically investigated. A careful study was made of the effect of wide variations of the several factors involved in the application of the chemical to the catgut; such, for example, as the strength of the solutions, the duration of the chemical sterilizing treatment (time of contact), the hydrogen-ion concentration and temperature of the solutions, buffering of solutions, as well as combinations of the chemicals. Moreover, these studies included the effect of the sterilizing action of the chemical compounds on catgut ribbons, raw catgut strings, and artificially infected catgut.

Before attempting to evaluate the possible merits of any of the chemicals under investigation, a large number of sutures prepared in

various ways was subjected to the sterilizing action of the chemical under a wide variety of conditions; and the sutures were then tested bacteriologically by the standard method of Meleney and Chatfield.

In some of the early studies of this investigation, the bacteriological results were encouraging. Thus, the chemical compounds which seemed to give promise of exerting a true sterilizing action on catgut were metaphen, copper sulphate, diacetoxymercurioorthocresol, and iodine plus potassium iodide. However, if the bacteriological results indicated that some particular chemical apparently exhibited effective germicidal properties on some lots of catgut ribbons or of raw catgut strings, the experiment was repeated under precisely the same conditions, several additional lots of catgut being used, with the view of confirming the results. Invariably the bacteriological results of these confirming experiments failed to establish the reliability and effectiveness of the chemical as a sterilizing agent. But if the results still appeared to hold out promise of ultimate success and, therefore, to warrant still further experiments, artifically infected catgut was also subjected to the sterilizing treatment with that particular chemical compound.

Although several of the chemical compounds included in this study have been reported by various authors to possess germicidal properties for various surgical, medical, or laboratory purposes, *none of them proved to be efficient and reliable agents for the chemical sterilization of catgut.* Owing to the large number of tests that were applied, the tabulated results obtained with each of the various chemical compounds studied would occupy a very large amount of valuable space. Hence, it has been necessary to omit tables showing results with chemicals other than copper sulphate, peppermint oil, and mercuric oxide. The reason for including detailed and tabulated results obtained with these three chemicals must be apparent from the foregoing information relating to them.

Chemical sterilization inefficient. Thus far, the chemical compounds which have been tried out in an attempt uniformly and effectively to destroy the bacteria commonly present in raw catgut have given disappointing and unreliable results. Most chemicals have had an especially weak action upon the spore-forming bacteria which are often found in the innermost portions of the gut.

During the course of this investigation, the sterilizing action of each of the 27 chemical compounds studied was applied to a large number of lots of catgut sutures prepared from fresh sheep intestines under ideal sanitary conditions; also to many lots of artificially infected catgut. None of the chemicals was found to have reliable or uniform sterilizing action on catgut; and in no case did all lots of sutures, sterilized with any one of the chemicals or a combination of the chemicals, prove to be entirely free from living bacteria. Therefore, the net results indicate the fallacy of the chemical method of sterilizing catgut, so far as the chemical compounds included in this study are concerned.

This research work involved bacteriological studies of 334 experimental lots of catgut comprising several thousand sutures, together with 154 commercial lots embracing 1134 catgut sutures. The results of this investigation have proved conclusively that *chemical sterilization of surgical catgut as employed at present is inefficient and unreliable.* Hence, it becomes evident that chemically sterilized catgut sutures are unsafe because their sterility is uncertain; unless, of course, some chemical not included in this study or which may be developed in the future proves to be an effective sterilizing agent for catgut.

Heat sterilization effective and reliable. Unlike chemical disinfection, the efficiency of sterilization of catgut sutures by heat does not depend upon the absorption of ions. On the contrary, heat of an effective degree penetrates all parts of the cell colloid of any bacteria that may be within the catgut, and thus devitalizes the essential matter of the bacterial cell.

In my studies of the chemical sterilization of surgical catgut, each experiment was controlled by subjecting to heat sterilization a duplicate lot of catgut sutures that had been treated with the particular chemical being studied. In every instance, the heat-sterilized sutures came through the bacteriological tests

with entire absence of bacterial growth; thus proving that *heat sterilization, properly controlled, is the only safe and positive method for sterilizing surgical catgut sutures.* Moreover, there was no impairment of tensile strength as a result of the heat treatment; thus showing that with sufficient care, effective heat sterilization can be applied without altering the physical properties of the catgut.

SUMMARY

In this investigation, which extended over a period of 2½ years, several thousand catgut sutures were prepared from 334 lots of catgut. Twenty-seven different chemical compounds were used for treating these various lots of catgut under a wide variety of conditions, in an attempt to bring about chemical sterilization; the various chemical treatments having been applied to catgut ribbons, to raw catgut strings, as well as to artificially infected catgut.

The chemical compounds used in this research study included mercurochrome, mercurophen, merthiolate, metaphen, potassium-mercuric-iodide, hexylresorcinol, tribromresorcinol, orthophenylphenate, ethylhydrocuprene, tribrombetanaphthal, copper cyanide, copper chloride, copper sulphate, copper sulphate plus methylene blue, zinc sulphate, peppermint oil, oil of tea tree (Melaleuca alternifolia), hydrogen peroxide, malachite green, pyridium, iodine, iodine plus potassium iodide, myodine, parachlormetacresol, diacetoxymercurioorthocresol, parachlorphenol, and chlorthymol ester.

In applying the chemical sterilization processes, the effect of wide variations in the several factors involved was studied; including the strength of the chemical solutions, the duration of the chemical sterilizing treatment, the hydrogen-ion concentration and temperature of the solutions, buffering of solutions, and combinations of the chemicals. Duplicates of each lot of catgut that received chemical sterilization treatment were also subjected to heat sterilization as a control.

In addition to the large number of experimental lots of catgut which were subjected to the sterilizing action of the various chemical compounds before mentioned, this investigation also included a study of the sterility of 154 commercial lots purchased from the open market and comprising 1134 catgut sutures.

Throughout these experiments, the standard bacteriological test, devised and proposed by Meleney and Chatfield, was used for determining the sterility of catgut; but 3 additional controls were used and are recommended as essential for safeguarding the reliability and efficiency of the test.

The results of my experiments with copperized catgut sutures herein described have demonstrated that copper salts applied to catgut by the von Linden method do not effectively sterilize catgut. These findings confirm those of Weichardt, as reported by Mehnert (8). Moreover, my copperized catgut experiments have shown that copper salts exert a bacteriostatic action on the bacteria in catgut; for, when the copper is removed with a suitable neutralizing fluid, the bacteria become reactivated.

It was found that the 1 per cent solution of sodium thiosulphate and sodium carbonate, used by Meleney and Chatfield in their standard test for neutralizing mercury compounds and iodine, will not remove copper salts from catgut sutures. A solution consisting of 5 per cent ammonium chloride and ½ per cent ammonium hydroxide was found to be an effective neutralizing agent for dissolving and removing copper salts from catgut.

Copperized catgut sutures embedded in animal tissues were less readily absorbed and were definitely more irritating than plain (untreated) catgut sutures.

Chemical analyses of catgut sutures of three American manufacturers and of one German manufacturer revealed appreciable quantities of copper. Bacteriological examinations showed the presence of living bacteria in 42 of 156 (approximately 27 per cent) of the copperized sutures of the 3 American manufacturers; and in 19 of 36 (52 per cent) of the copperized sutures of German make (von Linden process).

Peppermint oil catgut sutures were demonstrated by repeated bacteriological tests to be 100 per cent non-sterile. This method of sterilizing catgut, recommended by Porritt, not only fails to sterilize artificially infected cat-

gut but even the ordinary run of raw catgut made from fresh sheep intestines and processed under ideal sanitary conditions.

Chemical analyses of catgut sutures marketed in 1932 by an American manufacturer revealed a large amount of a mercury compound; and, when such sutures were examined bacteriologically by the standard test of Meleney and Chatfield, entire absence of bacterial growth was indicated. The large amount (3.5 per cent) of the mercury compound could not be removed from the sutures by the neutralizing solution of 1 per cent sodium thiosulphate and sodium carbonate used in the Meleney and Chatfield test; but it was found that a neutralizing fluid of 10 per cent sodium thiosulphate effectively removes the mercury compound from the sutures. When sutures of this manufacturer were tested bacteriologically by first incubating them for 24 hours in a sterile 10 per cent solution of sodium thiosulphate and then by putting them through the standard Meleney and Chatfield technique, the results showed the presence of living bacteria in the sutures.

Bacteriological tests, applied to commercial catgut sutures containing a large amount of a mercury compound, have shown that arrested development of bacteria within the catgut is brought about through the bacteriostatic action of the mercury compound. These tests have also proved that removal of the mercury compound from the sutures, by means of a suitable neutralizing fluid, reactivates the bacteria which then are able to grow in the culture medium.

None of the 27 chemical compounds studied in this investigation was found to have reliable or uniform sterilizing action on catgut; for in no case did all lots of sutures, sterilized with any one of the chemicals or a combination of the chemicals, prove to be entirely free from living bacteria. However, every one of the duplicate lots of sutures which were subjected to heat sterilization showed entire absence of bacterial growth.

CONCLUSIONS

1. When applying the standard bacteriological test of Meleney and Chatfield for determining the sterility of surgical catgut sutures, the details of the chemical treatment to which they have been subjected must be known; or else careful qualitative and quantitative chemical analyses of some of the sutures must first be made to ascertain the nature and amount of the chemical compound used to impregnate the sutures.

2. A suitable neutralizing fluid must be devised and used to dissolve and remove the particular chemical substance found in the catgut sutures, before applying the standard bacteriological test.

3. The necessity of incubating commercial catgut sutures for at least 15 days is clearly indicated by the results of bacteriological tests shown in Tables III and VIII, wherein the greatest number of growths occurred on the thirteenth day; and some growths appeared even as late as the fifteenth day (Table III). This confirms the findings of Meleney and Chatfield, who reported the appearance of the largest number of growths on the thirteenth day, and who recommended an incubation period of 15 days as a margin of safety.

4. When used with the three additional and essential controls herein described, and when used in conjunction with suitable neutralizing fluids for dissolving and removing the chemical compound with which the sutures may be impregnated, the standard bacteriological test proposed by Meleney and Chatfield seems to be an efficient and reliable test for the sterility of surgical catgut sutures.

5. The so called chemical sterilization of surgical catgut by any method yet devised is inefficient and unreliable.

6. Carefully controlled heat sterilization is the only uniformly reliable and positive method of sterilizing surgical catgut sutures.

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EXPERIMENTAL SHOCK: THE EFFECT OF BLEEDING AFTER REDUCTION OF THE BLOOD PRESSURE BY VARIOUS METHODS[1]

N. W. ROOME, M.D., CHICAGO, W. S. KEITH, M.D., TORONTO, CANADA, and
D. B. PHEMISTER, M.D., F.A.C.S., CHICAGO
From the Department of Surgery, the University of Chicago

IN clinical surgery the effects of trauma or an operation are estimable by observations on the pulse, blood pressure, respiration, reflexes, color of skin and mucous membranes, and occasionally by other factors. Of these the blood pressure is commonly held the most important single index, and is frequently the only finding given much consideration. But since the blood pressure is maintained by several factors (ventricular contraction, peripheral resistance, blood volume, and viscosity), and may be reduced by alteration of any of these, the significance of a lowered pressure is very variable. It is, therefore, not a reliable guide to the condition of the patient without regard for the cause of its depression and for the other means of evaluating its importance. Thus a low pressure produced by hæmorrhage usually indicates a serious state of the circulation, in which further loss of blood or an operation is badly tolerated; but an equally low pressure occurring as a result of spinal anæsthesia may have no such significance, and an operation may be completed without undue risk. Hadenfeldt states from a study of a large series of spinal anæsthesias that the effect of loss of blood is no more serious under spinal than under general anæsthesia; Burch, Harrison, and Blalock, however, reached an opposite conclusion from animal experiments. It has been observed in this and other clinics that the blood pressure may fall considerably, with a concurrent slowing of the pulse, during upper abdominal operations such as cholecystectomy or gastric resection, without apparent cause, and rapidly return to normal levels upon closure of the abdomen, with no noticeable after-effects; Hadenfeldt assumes this effect to be due to traction on the vagus nerve below the diaphragm with reflex cardiac inhibition.

In an endeavor to test experimentally the value of blood pressure readings as an index of the condition of the circulation, and to evaluate the seriousness of the blood pressure fall of spinal anæsthesia, the blood pressure was lowered in dogs to "shock levels" by nine different methods, and the effect of bleeding the animals to death was studied. Certain observations made in the course of these experiments have a bearing on the general problem of the mechanism of traumatic shock, as to whether a histamine-like toxin is liberated from the damaged tissues (Cannon, 5; and Cannon and Bayliss, 6), or whether there is sufficient local loss of fluid to account for the fall of blood pressure (Blalock, 2; and Parsons and Phemister, 16). In addition it was attempted in several animals without success to reduplicate the fall of blood pressure which results in man after upper abdominal operations.

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EXPERIMENTAL METHODS

The blood pressure was reduced in a series of 50 dogs to levels usually between 50 and 70 millimeters of mercury by the following methods: hyperventilation, anaphylactic shock, histamine administration, spinal cord section, spinal anæsthesia, trauma to a limb, hæmorrhage, plasmapheresis, and intestinal manipulation. The animals were bled to death, in most experiments approximately 1 hour after the initiation of the procedure, and the amount of blood obtainable was measured. Anæsthesia was by ether or sodium-barbital. Blood counts were made in 37 cases, before and after the depression of the blood pressure. Bleeding was by a large carotid cannula, the animal being left in the horizontal position and the cannula kept free of clots; the bleeding volume thus obtained is presumed to be an approximate index of the circulating blood volume, and will be described in the remainder of this paper as a percentage of the calculated blood volume (one-thirteenth of the body weight). The experiments and the results obtained will be described in groups according to the method used to depress the blood pressure.

1. CONTROL SERIES

Twenty additional dogs were merely anæsthetized, 10 with ether and 10 with sodium-barbital, and bled at the end of an hour. The results are contained in Table I, and indicate that while there is a considerable individual variation of the bleeding volume, there is no significant difference in this respect between the two anæsthetic agents. The individual variations are probably due to (1) mechanical errors in bleeding, (2) individual characteristics, notably the proportion of fat to the other tissues of the animal, and (3) differences in the water content of the tissues and the alimentary tract. The percentages of the calculated blood volume obtained from the normal animals varied from 34 to 82 per cent, and averaged 58.6 per cent.

2. HYPERVENTILATION

Henderson (9) as early as 1905 described the depression of the blood pressure in acapnia, and offered this phenomenon as an initiating agent of surgical shock. Recent evidence (McDowell) indicates that acapnia has a dual effect on the circulation, a central vasodilatation which usually predominates, and a local constriction of smaller and more peripheral vessels.

a. *Hyperventilation by intratracheal insufflation.* Six dogs anæsthetized by sodium barbital were each hyperventilated by connection of a cannula in the trachea to two Palmer respiration pumps, arranged so as alternately to pump in and suck out the same volume of air, and operated at approximately 140 revolutions per minute. Due to temperature changes, this method of artificial respiration was found to result in slightly increased intrapulmonary pressure; this effect was minimized by connecting a T-tube in the system to permit communication with the atmospheric air. A rapid fall of blood pressure occurred in each case, and at the end of approximately 1 hour, while the artificial respiration was continued, the amounts bled were from 21 to 41.5 per cent of the calculated blood volume, the average being 32.7 per cent. Blood counts showed no constant or marked change.

b. *Hyperventilation by external alternating pressure.* From observations made on the dogs of Series 2a and other animals, it was concluded that in hyperventilation by the intratracheal method there are certain factors capable of causing a blood pressure fall independent of the degree of acapnia, viz., mechanical impairment of the pulmonary circulation, as noted by Janeway and Ewing, and reflex vasodilatation from increased intrapulmonary and intrabronchial pressure (Johnson and Luckhardt). Therefore a somewhat more physiological method of artificial hyperrespiration was devised (17), in which the animal was enclosed in a metal cylinder with its head projecting, in the manner of the Drinker respirator, and alternately positive and negative air pressure applied to the exterior of the body by connection to two Palmer pumps operated synchronously at approximately 115 revolutions per minute. When this method was applied to 5 dogs anæsthetized with sodium barbital, the blood pressure fell slightly immediately, recovered to nearly the normal level, then slowly fell to levels of from 52 to 69 millimeters of mercury. The bleeding volumes at these levels, while the artificial respiration was continued, were from 50 to 67 per cent of the calculated blood volume, averaging 56.2 per cent. This average is relatively much higher than that obtained in lowered pressures from intratracheal insufflation, even when the difference in terminal pressures is considered; this is a further indication that in the intratracheal method there is actual obstruction to the pulmonary circulation, while in the external pressure method the effects are more purely due to acapnia with secondary vasodilatation. For this reason, although the results of both series of experiments are included in Table II, only those of series 2b will be considered in the discussion to follow. It must also be noted that the external alternations of pressure would minimize any stagnation of blood in the veins, as has been suggested may occur in acapnia (Henderson, 10); but in these experiments a considerable fall of pressure occurred in the absence of such stagnation.

3. ANAPHYLAXIS

A fall of blood pressure occurs in dogs during "anaphylactic shock," the mechanism of which is not entirely clear but is presumably the same as with the analogous "histamine shock," i.e., by direct action on the capillaries (Sollman).

Eleven dogs were sensitized to pig's blood, and when under ether anæsthesia small amounts of the same blood were injected intravenously, anaphylactic shock of a satisfactory degree developed in 5 animals. In these the blood pressure fell rapidly to low levels, with a tendency to recover in some cases.

TABLE I.—BLEEDING VOLUMES OF NORMAL DOGS ANÆSTHETIZED FOR ONE HOUR

(a) Under ether anæsthesia		(b) Under sodium barbital	
Dog No.	Bled, per cent of the calculated blood volume	Dog No.	Bled, per cent of the calculated blood volume
422a	57.5	430	67.8
422b	53.2	433	53.6
442	64.5	434	82.4
445	50.3	435	57.0
494‡	33.9	449	67.0
241	67.2	456a	53.3
510*	42.5	447	75.1
511	60.3	453a	61.9
512	53.1	452	56.3
TR	65.6	451	47.1
Average	54.8	Average	62.4

Average of 20 dogs: 58.6 per cent of the calculated blood volume.

*Fat dog. ‡Very fat dog.

The time interval was necessarily short in this series, and the severity of the reaction was very variable. On bleeding, from 29 to 63 per cent of the calculated blood volume was obtained, the average being 51 per cent (Table III). Erythrocyte counts showed no constant change.

4. HISTAMINE ADMINISTRATION

The effects of histamine on the circulation are complex. In a few species it raises the blood pressure, while in dogs and most other animals it produces an extensive fall of blood pressure, apparently by direct action on the capillaries (Dale and Richards), the condition being similar to surgical shock (Mellanby).

Histamine (ergamin acid phosphate) was given in aqueous solution by a continuous intravenous drip in 5 dogs, and subcutaneously in 1 dog, No. 487. By both methods the blood pressure slowly fell to the desired levels. Four of the animals were anæsthetized with ether, 2 with sodium barbital. The amounts bled were from 36 to 66 per cent of the calculated blood volume, and the average was 50.5 per cent (Table IV). Blood counts were made in 5 cases; in 3 there was no significant change, in 2 there was a slight increase in the red cells.

5. SPINAL CORD SECTION

The spinal cord was cut after preliminary laminectomy, in the region of the first thoracic segment, in 6 dogs anæsthetized with ether. There was usually little bleeding during the laminectomy, and that incidental to cutting the cord was minimized by immediately packing the wound; the procedure thus represents the combination of a small operation with spinal cord section. The blood pressure reaction to the section was somewhat variable, but there was typically an immediate rise due to transient stimulation of the vasoconstrictor nerves, then a gradual fall in 25 to 40 minutes to levels of from 52 to 68 millimeters of mercury due to interruption of the vasomotor pathways. The amounts bled were from 41 to 51 per cent of the calculated blood volume, averaging 48 per cent (Table V). There was a slight decrease in the erythrocyte count in four of five cases.

TABLE II.—HYPERVENTILATION:

(a) By Intratracheal Insufflation

Experiment	Anæsthetic	Blood pressure		Time, minutes	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg.	At end, mm. Hg.		
390	S-B	153	56	57	34
392	S-B	136	54	67	41.5
396	S-B	145	53	65	21
398	S-B	148	53	61	30
402	S-B	170	67	63	35
403	S-B	122	60	67	35
Average			57	63	32.7

(b) By External Alternating Pressure

Experiment	Anæsthetic	Blood pressure		Time, minutes	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg.	At end, mm. Hg.		
410	S-B	146	54	80	51
411	S-B	126	63	99	58
415	S-B	136	68	113	67
416	S-B	152	69	110	55
440	S-B	103	62	83	50
Average			63	97	56.2

6. HIGH SPINAL ANÆSTHESIA

A 3 per cent solution of procaine in physiological salt solution was injected intrathecally in the upper lumbar region in 4 dogs after laminectomy and in 2 (Nos. 385, 417) without laminectomy. All were under light ether anæsthesia. Sufficient procaine was slowly injected to produce relaxation of the entire chest wall, and in some a slight slowing of the respirations. The blood pressure fell gradually and continuously as the anæsthesia spread upward, presumably by interference with conduction of vasomotor impulses in the efferent spinal nerves. From 38 to 55 per cent of the calculated blood volume was obtained, the average being 44 per cent (Table VI). No blood counts were made in this series.

7. TRAUMA TO AN EXTREMITY

Cannon and Bayliss (6) concluded that the fall of blood pressure after trauma to an extremity was due to the liberation of a toxic histamine-like substance

TABLE III.—ANAPHYLAXIS

Experiment	Anæsthetic	Blood pressure		Time, minutes	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg.	At end, mm. Hg.		
317	E	110	45	20	61
325	E	148	40	12	57
328	E	140	60	11	63
330	E	138	45	20	48
338	E	125	25	25	29
Average			43	18	51

TABLE IV.—HISTAMINE ADMINISTRATION

Experiment	Anæsthetic	Blood pressure		Time, minutes	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg.	At end, mm. Hg.		
363	E	148	54	76	47
364	E	155	58	60	66
365	E	172	62	58	50
367	E	128	56	65	36
449	S-B	110	47	21	54
487	S-B	152	43	41	50.5
Average			54	54	50.5

from the injured tissues, with generalized vasodilatation and increased capillary permeability. Later observations by Blalock (2) and Phemister and Parsons (16) have shown that there is sufficient local loss of fluid into the traumatized area to account entirely for the blood pressure fall.

In the present experiments, trauma was applied to one or both hind limbs of 4 dogs by many blows with a padded hammer; sodium barbital was the anæsthetic in all cases. The blood pressure usually fell but slightly with the first hammering, and more sharply with the successive hammerings; this is similar to the effect of repeated bleedings, as will be described. Blood counts showed a diminution in all cases. The bleeding volumes were from 23 to 26.5 per cent of the calculated blood volume, averaging 24.6 per cent (Table VII).

8. HÆMORRHAGE

In 7 dogs small amounts of blood were repeatedly withdrawn from a carotid artery; 5 of the animals were anæsthetized with sodium barbital and 2 with ether. Recovery of the blood pressure occurred sharply and nearly completely after the first few withdrawals, slowly and less completely after the later bleedings. Erythrocyte counts showed a diminution in all cases. From 19 to 35 per cent of the calculated blood volume was obtainable, the average being 24.9 per cent, after from 33 to 64 per cent of the calculated blood volume had been removed by bleeding (see Table VIII). The average

TABLE V.—SPINAL CORD SECTION

Experiment	Anæsthetic	Blood pressure		Time, minutes	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg.	At end, mm. Hg.		
296	E	116	52	25	50
340	E	130	68	60	49
341	E	110	65	60	51
342	E	154	54	65	41
344	E	138	58	45	52
345b	E	120	58	70	47
Average			59	51	48

total amount bled during the experiment and at the terminal bleeding was 70.4 per cent of the calculated blood volume; this increase over the amount obtainable at one continuous bleeding is presumably due to the absorption of fluid from the tissues during the slow bleeding.

9. PLASMAPHERESIS

The reduction of the blood pressure was attempted in several animals by the withdrawal of a quantity of blood after heparin administration, the plasma being removed by centrifugalization, and replacement of the cells; these experiments were unsuccessful, the time interval being very long, and death frequently occurred in the later stages before the cells could be replaced, as noted by Bayliss. Therefore the following plan was adopted, 2 animals being used: blood from dog 1 was drawn, centrifuged, and its plasma decanted; then dog 2 was bled, and cells from dog 1 immediately replaced in proportionate quantity. This process was repeated two or three times, until the blood pressure remained at a shock level (after from 34 to 52 per cent of the calculated blood volume had been removed as plasma), at which time the animals were bled to death. By this technique the time required was reduced to an average interval of 82 minutes; no reactions attributable to foreign protein were observed. The blood was, of course, concentrated by the procedure. In 5 cases the amounts bled were from 15.5 to 27 per cent of the calculated blood volume, and the average was 19.7 per cent. The average total volume of fluid removed during the experiment and at the terminal bleeding was 59.1 per cent of the calculated blood volume; this figure is lower than the average total volume removed during the hæmorrhage experiments and probably indicates that the greater loss of plasma proteins and correspondingly lower osmotic pressure of the blood in the plasmapheresis experiments permitted less withdrawal of the tissue fluids into the blood stream.

10. MANIPULATION OF THE INTESTINES

Experiments on intestinal manipulation in dogs by Phemister and Parsons indicate that the intestinal volume is not increased during the procedure,

TABLE VI.—HIGH SPINAL ANÆSTHESIA

Experiment	Anæsthetic	Blood pressure		Time, minutes	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg.	At end, mm. Hg.		
310	E	114	60	30	55
312	E	155	58	55	48
313	E	138	48	45	40
347	E	120	62	70	38
385	E	140	55	56	40
417	E	157	79	90	44
Average			62	58	44

TABLE VII.—TRAUMA TO AN EXTREMITY

Experiment	Anæsthetic	Blood pressure		Time, minutes	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg.	At end, mm. Hg.		
497	S-B	114	42	52	24
499	S-B	113	44	60	25
508	S-B	166	60	93	26.5
510	S-B	207	51	56	23
Average			49	65	24.6

TABLE VIII.—HÆMORRHAGE

Experiment	Anæsthetic	Blood pressure		Time, minutes	Amount bled during experiment, per cent of the calculated blood volume	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg	At end, mm. Hg.			
369	E	180	64	65	39	20
374	E	127	58	66	34	19
473	S-B	160	60	76	59	26
474	S-B	154	64	73	64	19.5
475	S-B	142	74	63	33	29
476	S-B	102	61	57	.....?	25.7
498	S-B	150	47	30	44	35
Average			61	61	45.5	21.9

and Blalock (3) found that a plasma-like exudation occurs from the surface of the intestine in adequate amounts to explain the fall of blood pressure.

In 6 dogs of the present series the intestines were brought out through an abdominal incision and severely massaged with the fingers; 5 were anæsthetized with ether, 1 with sodium barbital. There was little or no external hæmorrhage, although moderate ecchymosis occurred in the area manipulated, and a considerable weeping from the surface of the bowel was observed, as described by Blalock. The fall of blood pressure was very gradual and could not be much accelerated by more vigorous massage; hence the time interval was increased to an average of 104 minutes. The bleeding volumes were from 12 to 21 per cent of the calculated blood volume, the average being 18 per cent. The erythrocyte counts were irregularly increased, indicating a concentration of the blood in all cases.

II. UPPER ABDOMINAL MANIPULATIONS

The fall of blood pressure which occasionally occurs during operations in the upper abdomen in man, and which is usually accompanied by a slowing of the pulse, is presumably a reflex phenomenon, and may be related to the cardio-inhibitory reflex from the upper abdomen of certain species, and easily demonstrable in the frog (Luckhardt).

Several unsuccessful attempts were made to reduplicate this effect in dogs, by traction upon and resection of the gall bladder and stomach, and by stimulation electrically of the gastric vagi below the diaphragm. No satisfactory fall of blood pressure of adequate duration for study could be obtained in the dogs tested.

DISCUSSION OF RESULTS OF EXPERIMENTS

The results of all types of experiments are summarized in Table XI. It will be noted that the average bleeding volume for the normal anæsthetized dogs (series 1) was 58.6 per cent of the calculated blood volume, and that the bleeding volumes after reduction of the blood pressure fall into two groups according to whether there is a slight or a marked reduction of the bleeding volume.

The first group includes the following procedures: hyperventilation, anaphylaxis, histamine administration, spinal cord section, and spinal anæsthesia. In these (series 2b to 6, inclusive), there was obtained from 44 to 56 per cent of the calculated blood volume, figures but slightly diminished from the normal; and the two lowest figures of the group were in the conditions of spinal anæsthesia and spinal cord section, in which a small operation was included in the procedure. The mechanism of the blood pressure depression in these experiments was by arteriolar or capillary dilatation or both, and the maintenance of nearly normal bleeding volumes indicates that the circulating blood volume is not greatly diminished.

In the conditions of trauma to an extremity, and hæmorrhage (series 7 and 8) there was obtainable at similar blood pressure levels a much smaller volume of blood, approximately 25 per cent of the calculated blood volume; and an even greater reduction of the bleeding

TABLE IX.—PLASMAPHERESIS

Experiment	Anæsthetic	Blood pressure		Time, minutes	Plasma removed, per cent of the calculated blood volume	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg.	At end, mm. Hg.			
536	S-B	136	72	85	52	21
538	S-B	126	83	95	36	17.6
542	S-B	158	58	97	38	15.5
547	S-B	138	62	77	34	17.5
551	S-B	138	59	64	37	27
Average			67	82	39.4	19.7

TABLE X.—INTESTINAL MANIPULATION

Experiment	Anæsthetic	Blood pressure		Time, minutes	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg.	At end, mm. Hg.		
321	E	140	50	170	18
332	E	110	30	60	20
334	E	145	45	112	19
335	E	90	50	112	21
336	E	142	45	85	18
412	S-B	179	56	88	12
Average			46	104	18

TABLE XI.—SUMMARY OF ALL TYPES OF EXPERIMENTS

Series	Procedure	Number of cases	Average bleeding volume, per cent of the calculated blood volume
1	Normal dogs	20	58.6
2b	Hyperventilation	5	56.2
3	Anaphylaxis	5	51.0
4	Histamine administration	6	50.5
5	Spinal cord section	6	48.0
6	Spinal anæsthesia	6	44.0
7	Trauma to an extremity	4	24.6
8	Hæmorrhage	7	24.9
9	Plasmapheresis	5	19.7
10	Intestinal manipulation	6	18.0

volume occurred after lowering the blood pressure by plasmapheresis, and by manipulation of the intestines (series 9 and 10), approximately 20 per cent of the calculated blood volume being obtained. These 4 series constitute a second group of experiments, in which a considerable reduction of the bleeding volume occurred as a result of actual loss of circulating blood volume. The erythrocyte counts made in this group, although somewhat irregular, indicated a dilution of the blood in extremity trauma and hæmorrhage, and a concentration of the blood in plasmapheresis and intestinal manipulation; the corresponding differences in viscosity may account for the differences in the bleeding volumes, i.e., the more concentrated blood of plasmapheresis and intestinal manipulation may permit a smaller circulating blood volume to maintain a given blood pressure than the diluted blood of trauma and hæmorrhage. As has already been noted, the blood pressure behaved similarly in its reaction to repeated withdrawals of blood and to repeated traumatizations of an extremity, there being little effect at first and an increasing effect later in the procedure. The coincidence of the bleeding volumes of this group of experiments and the other findings support the opinion that the fall of blood pressure in experimental trauma and intestinal manipulation is due to local loss of fluid, as blood or blood and plasma into the damaged tissues and as plasma exudation from the intestine.

By comparing the bleeding volumes of the two groups of experiments it is apparent that the animals of the first group were in much better condition, by virtue of their nearly normal circulating blood volume, to withstand hæmorrhage or an operation than the animals of the second group, in which the bleeding volume was markedly reduced, during the time period considered in the present studies. Therefore, a lowered blood pressure of such duration is not as serious a condition when produced by vasodilatation or "bleeding into the vessels," as some writers have implied, as when the pressure is lowered to similar levels by actual loss of fluid from the circulation, as in experimental trauma, intestinal manipulation, and hæmorrhage.

While these experimental procedures do not exactly simulate surgical shock in man, the findings apply to the problem of its mechanism at least in part. Therefore, it is thought that in clinical shock (1) the hidden loss of fluid, for instance locally into the tissues in trauma, may be more important as an etiological agent than toxæmia or other suggested

factors; (2) the blood pressure is not in itself an adequate guide as to the condition of the patient, as it may be nearly normal in the presence of a seriously embarrassed circulation, or vice versa; and (3) further hæmorrhage or an operation is more dangerous when the blood pressure is lowered by hæmorrhage or by trauma, in which blood or plasma is lost, than by spinal anæsthesia or other vasodilator mechanism, in which there occurs the so called "bleeding into the vessels." And clinical experience warrants the inclusion in the vasodilator group the depression of the blood pressure which occurs during upper abdominal operations with a concurrent slowing of the pulse. Spinal anæsthesia was demonstrated to have but slight influence on the bleeding volume and presumably the circulating blood volume, and is therefore to be considered but slightly more dangerous than ether or barbital anæsthesia.

SUMMARY

The state of the circulation in 50 anæsthetized dogs, after lowering the blood pressures to "shock levels" by 9 different methods, was studied by comparing the average bleeding volumes of each series, i.e., the average amount of blood obtained by bleeding, usually after the lapse of 1 hour. The average bleeding volume of 20 normal anæsthetized dogs was 58.6 per cent of the calculated blood volume. The experiments fell into two groups, according to whether or not a considerable diminution of the bleeding volume occurred at the reduced pressure.

In the first group of experiments the average bleeding volume was 56.2 per cent of the calculated blood volume when the blood pressure was lowered by hyperventilation, 51 per cent when by anaphylaxis, 50.5 per cent when by histamine administration, 48 per cent after spinal cord section, and 44 per cent with high spinal anæsthesia. The average bleeding volume for the entire first group was 49.9 per cent of the calculated blood volume, a slight depression from the normal average. In the conditions enumerated the mechanism of depression of the blood pressure was by dilatation of the arterioles or capillaries or both. It was concluded that in these conditions, during the time interval studied, there was little or no diminution of the circulating blood volume at the reduced pressure; and it would seem that the lowered blood pressure of spinal anæsthesia did not appreciably increase the dangers of operation or hæmorrhage, since the blood volume remained at or near normal.

In the second group of experiments the average bleeding volume was found to be 24.9 per cent of the calculated blood volume after the blood pressure had been lowered by hæmorrhage, 24.6 per cent when by trauma to an extremity, 19.7 per cent after plasmapheresis, and 18 per cent after intestinal manipulation. The average for the entire group was 21.8 per cent of the calculated blood volume, and was thus very considerably reduced from the normal. In the case of hæmorrhage and plasmapheresis there was direct and obvious loss of fluid from the blood stream; and a similar loss presumably occurred in the conditions of trauma, where there was local loss of blood and plasma into the injured area, and in intestinal manipulation, where the fluid appeared to be lost principally as plasma. It was concluded that in this second group of experiments the circulating blood volume was much more seriously diminished at similar blood pressure levels than in the first group, and that the animals were correspondingly less able to withstand hæmorrhage or an operative procedure. The similarity of the bleeding volumes was further evidence that the mechanisms of lowering the blood pressure are identical in trauma to an extremity and hæmorrhage, and in intestinal manipulation and plasmapheresis.

CONCLUSIONS

1. In states of circulatory depression the blood pressure is an inadequate index of the seriousness of the condition.

2. The circulating blood volume is not seriously diminished, and hence operation or loss of blood is well tolerated, in conditions of lowered blood pressure due to vasodilator mechanisms, such as spinal anæsthesia, and including presumably the fall of blood pressure which sometimes occurs in upper abdominal operations in man with a concurrent slowing of the pulse.

3. The circulating blood volume is markedly diminished when the blood pressure is reduced by hæmorrhage, experimental extremity trauma, or experimental intestinal manipulation. In these conditions the animal is much less able to withstand further hæmorrhage or an operation than if the blood pressure be depressed to a similar degree by a vasodilator mechanism.

4. The effects of experimental trauma and intestinal manipulation on the blood pressure are due to local loss of fluid rather than to a toxæmia.

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PASSIVE ANTITOXIC IMMUNITY IN STREPTOCOCCAL INFECTION OF THE PERITONEUM

ROBERT S. SMITH, B.A., B.Sc. (OXON.), ST. LOUIS, MISSOURI
From the Sir William Dunn School of Pathology, University of Oxford, Oxford, England

ALTHOUGH antibacterial sera have been discredited as agents for the prevention and treatment of streptococcal infections in the reports of McLeod, Novak, and others, antitoxic sera are at present enjoying considerable popularity. Warnekros, Louros, and Becker, Gaessler, and Lash have prepared antitoxic sera, using puerperal strains of streptococci, and describe the favorable effect of such sera in severe infections in the puerperium. Furthermore, in accordance with the concept of the unity of the streptococcal toxins, which is supported by the experimental work of Paraf, Eagles, Smith, Parish and Okell, Moriwaki, and Wadsworth, antibodies specific for the toxins of scarlet fever streptococci are being applied in the treatment of a variety of other streptococcal diseases.

Schabetai has used scarlatinal antitoxin with success in the treatment of erysipelas. Sanderson, Capon, and MacWilliam have found that the administration of scarlatinal antitoxin produces a favorable effect in streptococcal septicæmias. Boente, and Killian have described the successful use of scarlatinal antitoxin in the treatment of a number of different diseases having a streptococcal etiology, including puerperal fever, acute angina, lung abscess, mastitis, and cellulitis. Baird and Cruickshank have reported a reduction in the incidence of puerperal infection by prophylactic administration of scarlatinal antitoxin. Few reports, however, of specific treatment of streptococcal infection of the peritoneum using antitoxic sera are to be found in the literature. Wilkie obtained encouraging results with the therapeutic administration of convalescent serum in streptococcal infections of the peritoneal cavity, and Duncan has suggested that it may be advisable to give scarlatinal antitoxin in the treatment of primary streptococcal peritonitis in children.

The present work was undertaken to determine experimentally the potentialities of antitoxin in the treatment of a streptococcal infection of the abdominal cavity, and to investigate the bodily reactions associated with passive antitoxic immunity in such a disease. The experiments were limited to an investigation of the infective process produced by a Dochez strain of streptococcus, isolated originally from a case of scarlet fever. The organism was only moderately virulent, but an active producer of toxin, filtrates of 72 hour tryptic digest broth cultures giving a positive skin test in a susceptible individual in a dilution of 1:10,000, and killing rabbits of 1800 to 2000 grams weight within 24 hours when injected intravenously in doses of 10 cubic centimeters.[1]

EXPERIMENTAL

Prophylactic effect of antitoxin. Ten rabbits, that had received subcutaneous injections of 2 cubic centimeters of antitoxin 16 hours previously, with ten normal controls, were given an intraperitoneal injection of 10 cubic centimeters of 16 hour tryptic digest broth culture of the streptococcus. The animals were studied in pairs, one protected by antitoxin and one unprotected, and were selected according to breed, sex, and weight. Of these rabbits, all of the unprotected died in 6 to 20 hours; all of the protected animals survived and were killed at intervals after recovery from the acute infection. Three of the surviving animals were killed after 1 week; 1, after 2 weeks; 1, after 3 weeks; and 5 were allowed to live for 30 days. In this experiment, changes in weight, temperature, peritoneal fluid, and blood picture, including total white blood cell count, white blood cell differential count, red blood cell count, hæmoglobin percentage, and blood culture, were studied, particular attention being paid to the sequence of events in the blood and peritoneal fluid during the first 6 hours.

[1] The antitoxin used in all experiments was that produced by Burroughs-Wellcome Company, and known as concentrated streptococcus antitoxin (Scarlatina) globulins.

TABLE I.—DIFFERENTIAL COUNTS OF PERITONEAL FLUID LEUCOCYTES

Rabbit 668—Polish male, 1660 grams; antitoxin before infection. (Numbers = percentages.)

	Monocytes	Eosinophiles	Lymphocytes	Polymorphs	Macrophages
Start	80	0	20	0	0
20 mins.	40	0	20	20	0
2 hrs.	2	1	1	96	0
6 hrs.	0	1	1	94	4
24 hrs.	2	0	0	90	8
48 hrs.	11	0	4	62	23
5 days	13	0	4	48	35
Week	8	0	11	49	32
30 days	40	4	56	0	0

Rabbit 669—Polish male, 1840 grams. Control.

	Monocytes	Eosinophiles	Lymphocytes	Polymorphs	Macrophages
Start	83	0	17	0	0
20 mins.	50	0	50	0	0
2 hrs.	0	5	15	80	0
6 hrs.	2	10	6	82	0

Animal dead in twenty hours.

TABLE II.—BLOOD LEUCOCYTES IN INFECTIONS—POLYMORPHONUCLEAR AND LYMPHOCYTE COUNTS (PER CUBIC MILLIMETER OF BLOOD)

Rabbit 663—Chinchilla male, 1930 grams; antitoxin before infection.

	Total WBC	Polymorphonuclears		Lymphocytes	
		Per cent	Absolute count	Per cent	Absolute count
Start	10,600	33	3,498	44	4,664
20 mins.	15,500	58	8,990	30	4,650
2 hrs.	3,600	69	2,484	25	900
6 hrs.	5,100	81	4,131	15	765
20 hrs.	7,200	64	4,608	28	2,016
48 hrs.	21,800	52	11,336	18	3,924
72 hrs.	16,000	36	5,760	37	5,920
96 hrs.	24,400	62	15,128	16	4,904
Week	17,000	43	7,310	34	5,780
30 days	14,800	33	4,884	55	8,140

Rabbit 664—Chinchilla male, 1850 grams. Control.

	Total WBC	Polymorphonuclears		Lymphocytes	
		Per cent	Absolute count	Per cent	Absolute count
Start	8,400	34	2,856	53	4,452
20 mins.	5,200	51	2,652	38	1,976
2 hrs.	1,000	33	330	52	520
6 hrs.	3,000	30	900	55	1,650

Dead after 20 hrs.

As a control upon the specificity of the protection conferred by the streptococcus antitoxin, rabbits that had received prophylactic injections of concentrated diphtheria antitoxin-globulins[1] were inoculated intraperitoneally with the standard dose of streptococcus culture. These animals succumbed to the infection in the same time as the normal controls.

After the injection of culture, the unprotected animals gave symptoms of a greater toxæmia than the passively immunized group, and were usually prostrated by a diarrhœa during their short period of resistance to the infection. All of the animals receiving antitoxin showed an increase in temperature, within 6 hours, to a level above 104 degrees F. In the unprotected controls on the other hand, an inhibition of the temperature reaction was noted, 8 of these animals showing a temperature below 100 degrees F. 6 hours after the injection of culture. Examinations of the leucocytes of the peritoneal fluid in film preparations demonstrated that the mobilization of polymorphonuclear leucocytes in the abdominal cavity during the acute phase of the infection was more pronounced in the immunized animals than in the control group; and phagocytosis of the infecting organisms was more effective in the animals receiving antitoxin. In the protected animals the phase of recovery from the infection was characterized by a diminution in the numbers of the polymorphonuclear cells in the peritoneal fluid, with a restoration of the normal predominance of the mononuclear leucocytes (Table I).

In the blood, an early leucocytosis, followed by a marked leucopenia, was characteristic of the reaction to the inoculation with streptococcal culture in both the immunized animals and the controls. The animals receiving antitoxin showed, however, a greater leucocytosis in the first 20 minutes; and the succeeding leucopenia was less pronounced in this group

[1] Burroughs-Wellcome product.

Fig. 1.

Fig. 2.

Fig. 1. Photomicrograph of peritoneal exudate from a normal animal 7 hours after injection of culture. Polymorphonuclear leucocytes have degenerated appearance. Phagocytosis is failing: free streptococci marked *s*. × 580.

Fig. 2. Peritoneal exudate from immunized animal 7 hours after injection of culture. Effective phagocytosis is shown; leucocytes contain cocci. × 580.

Fig. 3.

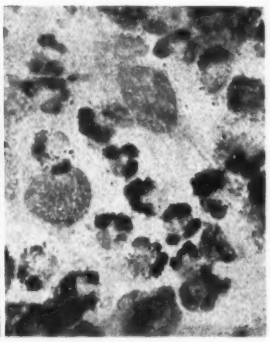

Fig. 4.

Fig. 3. Photomicrograph of omentum of unprotected animal 7 hours after inoculation. Failure of phagocytosis demonstrated. Free streptococci, *s*. × 580.

Fig. 4. Photomicrograph of omentum of protected animal 7 hours after inoculation. There is a marked polymorphonuclear reaction, and streptococci are within phagocytes. × 580.

The averages of the white blood cell counts per cubic millimeter of blood after 20 minutes and 6 hours in the two groups of animals were as follows: 20 minutes—immunized animals 23,135, controls 15,665; 6 hours—immunized animals 6,090, controls 4,922. The leucopenia was continued until death in the group of unprotected rabbits. In the protected group, however, a second and more prolonged leucocytosis was commonly observed after 48 hours.

Differential and absolute counts of the white blood cells showed that the polymorphonuclear leucocytes were of the chief importance in the leucocytic reaction to the acute infection (Table II). Depression of the polymorphonuclear response was noted in the group of unprotected animals.

Blood cultures indicated that a more severe bacteriæmia occurred in the unprotected rabbits. Six hours after infection, all of these animals gave a positive blood culture, while only one test was positive in the protected group after the same interval.

A moderate anæmia and a decrease in weight were characteristic of the first week following infection in the animals protected by antitoxin. After 30 days, the hæmoglobin percentage and red blood cell count had returned to their normal values in most animals; and compensation had usually been made for the initial weight loss. Two of the rabbits protected by antitoxin developed within the first week an arthritis affecting the joints of the hind legs. These inflammations persisted until the animals were killed, after 2 and 3 weeks, respectively.

Postmortem, the normal controls showed the histological changes characteristic of an acutely fatal infection. The peritoneal fluid and the membranes of the abdominal cavity showed a failure of the leucocytic reaction, with proliferation of the streptococci; and cultures of the heart blood and peritoneal fluid were uniformly positive for the organism. In the anterior mediastinal lymph nodes, numerous streptococci were observed in the lymph sinuses. Organisms were also readily demonstrated in sections of the liver and spleen of animals dying later than 10 hours after injection with culture. Foci of necrosis were observed in the liver. Acute congestion of the lungs, spleen, and kidneys was noted; and hæmorrhages were found in the heart muscle. Evidences of a severe drain upon the leucoblastic tissues were observed in sections of the bone marrow, with degenerative changes in the hæmatopoietic cells. The picture presented in this group of animals was that of a toxæmic depression of the vital systems of the

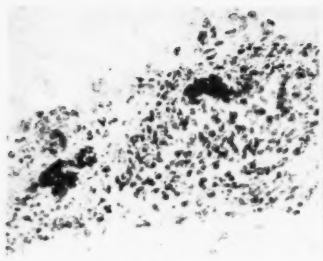

Fig. 5.

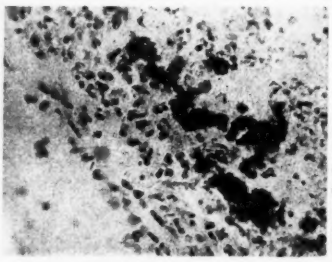

Fig. 6.

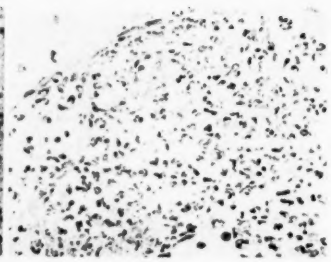

Fig. 7.

Fig. 5. Diaphragmatic lymphatic of unprotected animal 7 hours after inoculation. Streptococci, *s*. × 290.

Fig. 6. Photomicrograph of peripheral lymph sinus of anterior mediastinal lymph node in unprotected animal 7 hours after inoculation. Dark masses are aggregations of streptococci. × 290.

Fig. 7. Photomicrograph of peripheral lymph sinus of anterior mediastinal lymph node in immunized animal 7 hours after inoculation. There is a marked concentration of polymorphonuclear leucocytes; no bacteria are to be seen. × 290.

body, especially that concerned with leucocytic reaction to pathogenic bacteria, allowing a generalized invasion of the body from the original focus of infection in the abdomen.

In the protected animals, killed after their survival of the acute phase of the infection, a marked hyperplasia of the lymphoid tissues throughout the body was observed, with a pronounced myeloblastic reaction in the bone marrow. A marked development of myeloid tissue was also noted in the spleen in animals killed 1 week after infection. In addition to the 2 cases of arthritis already noted, a subacute pericarditis was found in one animal at autopsy. In the group of immunized animals, recovery from the infection of the abdominal cavity was apparently correlated with an intense reaction of the leucoblastic tissues of the body. The residual chronic foci of infection found in these animals, in spite of the prophylactic administration of antitoxin, undoubtedly had their origin in a blood stream infection associated with the acute peritonitis.

Comparison of immunized animals with normal controls in same phase of acute infection. In order to compare the histological changes in the protected and unprotected animals during the same phase of the acute infection, 4 rabbits receiving prophylactic injections of streptococcus antitoxin, with 4 normal controls, were killed 7 hours after having been inoculated intraperitoneally with 10 cubic centimeters of standard culture; and complete autopsies were performed.

Total counts of the cells of the peritoneal exudates in these animals post mortem demonstrated that the leucocytic response in the immunized rabbits was quantitatively greater than that in the controls. A greater quantity of exudate was present in the abdominal cavity of the immunized animals; and, when total counts were made of the peritoneal leucocytes, the average number of cells in the protected group was found to be 8,500 per cubic millimeter of fluid, as compared with an average count of 625 per cubic millimeter in the controls. The predominance of polymorphonuclear cells among the leucocytes of the peritoneal fluid was also more pronounced in the protected rabbits than in the controls. The average of the polymorphonuclear percentages in the immunized rabbits was 96, as compared with a corresponding average of 67 in the control group.

A greater mobilization of leucocytes in the tissues of the omentum, with more marked phagocytosis of the infecting organisms, was noted in the immunized animals; and preparations of the diaphragmatic lymphatics and anterior mediastinal lymph nodes also gave evidence of a more effective leucocytic reaction to the bacterial invasion in this group. Centers of proliferation of the streptococci were seen in the omentum, diaphragmatic lymphatics, and anterior mediastinal lymph nodes in the normal controls.

Therapeutic effect of antitoxin. Six rabbits were given an intravenous injection of 2

Fig. 8.

Fig. 9.

Fig. 10.

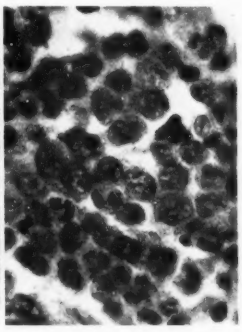

Fig. 11.

Fig. 8. Photomicrograph of liver of unprotected animal dying 20 hours after inoculation. Dark mass is aggregation of bacteria. × 525.

Fig. 9. Photomicrograph of liver of unprotected animal dying 20 hours after inoculation. Marked necrotic changes in liver cells. × 525.

Fig. 10. Photomicrograph of bone marrow of unprotected animal dying 20 hours after inoculation. Nuclear degeneration in myelocytes is shown. × 525.

Fig. 11. Photomicrograph of bone marrow of immunized animal 1 week after inoculation. Marked hyperplasia of leucoblastic tissues. Myelocyte is predominant cell, although many mature polymorphonuclear leucocytes are present. × 525.

cubic centimeters of concentrated streptococcus antitoxin 3 hours after having received 10 cubic centimeters of culture intraperitoneally. The time interval between the inoculation with culture and the injection with immune serum was of sufficient length to make the test one of considerable severity. A significant prolongation of life resulted, however, in all instances but one following the administration of the specific antiserum.

As compared with an acutely fatal infection of 10 hours' duration in 3 control rabbits, receiving therapeutic injections of diphtheria antitoxin, the disease in the animals given specific therapy was chronic in nature. The rapid course of the infection was unaffected in one animal which was given streptococcus antitoxin; 3 others died after 80 to 128 hours; 2 of this group made a complete recovery. In the overwhelming infection of these experiments, therapeutic injection of streptococcus antitoxin was commonly followed by an increase in temperature, increased phagocytosis of the streptococci by the leucocytes of the peritoneal exudate, and a rise in the blood leucocyte count. The pathological changes noted at autopsy in animals dying after several days of resistance to the infection were those of a severe septicæmia.

Control experiments. The changes in temperature, blood picture, and peritoneal fluid observed in experiments in which intraperitoneal injections were made of simple digest broth, and of the filtrate of a 16 hour streptococcal culture, showed that the inoculum of the reported experiments contained toxic substances apart from the bacteria themselves. The toxicity of these substances was not great, however; and the irritating properties of the products of bacterial metabolism present in cultures after 16 hours of incubation may be considered to constitute a constant factor in the experimental infections.

SUMMARY AND CONCLUSIONS

1. In the present work, it has been found that a high degree of immunity to intraperitoneal inoculation with a toxigenic, moderately virulent, scarlatinal streptococcus can be produced by the administration of specific antitoxin. From the experimental evidence, this immunity seems to depend upon the neutralization by the antibody of toxin produced by the infecting organism *in vivo;* and the resistance of the body to the infection, which is facilitated by the elimination of the toxic factor, is manifested by an increase in temperature, a local and general mobilization of leucocytes, and the removal of the invading bacteria from the peritoneal cavity and blood stream by phagocytic cells. The immunity conferred by the prophylactic administration

of antitoxin enables the animal body to survive the acute phase of a disease which is rapidly fatal for the unprotected control; but even this high degree of antitoxic immunity is not sufficient to prevent the development, in a certain percentage of cases, of later chronic infections. Therapeutic use of antitoxin has definite limitations, as indicated by the experimental results. The administration of the antitoxin after the onset of the infection appears to enhance the defensive powers of the body, however, and may be followed by a completely successful resistance to the bacterial invasion, and recovery.

2. The findings in these experiments substantiate the view of Downie, that toxin aids the establishment of streptococcal infection by inhibiting phagocytosis. As neutralizing toxin, and favoring the leucocytic reaction to the bacterial invasion, antitoxin appears to possess distinct potentialities for the control of infections of the abdominal cavity caused by toxigenic streptococci.

3. The present work indicates that the highest degree of passive antitoxic immunity in streptococcal infection of the peritoneum is produced by prophylactic administration of the serum. In the therapeutic use of antitoxin, it would seem, however, that the administration of the serum very early in the disease might confer a protection comparable to that produced by prophylactic injection. Early therapeutic administration of antitoxin should restrict tissue invasion to a minimum, and thereby limit the possibility of infections of a focal nature developing as complications.

This report represents a summary of experiments performed by the writer as a Rhodes Scholar, elected from the Washington University School of Medicine (1930–1932). The writer is greatly indebted to Professor Georges Dreyer, F.R.S., for his advice and material support in carrying out these experiments. He also wishes to express here his gratitude for very stimulating criticisms and suggestions that have been received from Dr. A. W. Downie of the University of Manchester, Professor J. W. McLeod of the University of Leeds, Dr. G. H. Eagles of the Lister Institute, Professor D. F. Cappell of the University of St. Andrews, Professor D. P. D. Wilkie of the University of Edinburgh, and Dr. T. B. Heaton, Dr. R. L. Vollum, and Dr. H. M. Carleton of the University of Oxford.

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THE TREATMENT OF LATE ACUTE INTESTINAL OBSTRUCTION

Recent Experimental and Clinical Studies[1]

ROBERT ELMAN, M.D., St. Louis, Missouri
From the Department of Surgery, Washington University Medical School and Barnes and St. Louis City Hospitals

IN this discussion of acute intestinal obstruction I shall be concerned almost entirely with the late and therefore serious cases which of course offer the greatest problem in treatment. The patient seen early generally does very well and such cases carry a low mortality even after a radical operation for relief. It is obvious therefore that the education of the public as well as the profession in early diagnosis would reduce the tremendously high mortality. Moreover if the use of purgatives for abdominal pain were generally avoided I am sure the treatment would also be easier and more favorable. Unfortunately we cannot wait until such education becomes effective. The mortality (15) of intestinal obstruction is still around 60 per cent, as high as it ever was, in spite of the great amount of research on the subject. In 1926, in the mortality statistics of this country over 10,000 deaths were recorded from intestinal obstruction. We are confronted constantly with patients in the later stages of this disease. It is the consideration of such patients to which I wish to direct attention.

A woman, for example, some weeks or months after a simple hysterectomy suddenly develops abdominal cramps which go away as quickly as they come only to return in a few minutes or after an hour or two. The patient thinks it is an ordinary belly ache and takes a dose of salts, has a moderate bowel movement, but the pain continues and she notices that her abdomen is becoming more distended. She then takes some castor oil but the pain becomes worse and she vomits. The distention becomes more marked and the pain perhaps diminishes in severity. The vomitus may become foul in odor. A doctor is called, she is rushed to the hospital, operated upon, and dies: or she may not call a doctor and dies without benefit of a diagnosis.

What was the cause of death? We are accustomed to explain the symptoms of prostration and weakness which develop before death as due to a toxæmia, in spite of the fact that we have no absolute evidence that this is in fact true. During the past few years a series of new observations have been made as to the cause of death which have contributed greatly to our understanding and treatment of certain of these cases. Some of this work has been done in the Surgical Laboratory at the Washington University Medical School and in Barnes and other hospitals associated with it. In order to present these observations more clearly it will be of advantage for purposes of discussion to divide intestinal obstruction into two groups: (1) High obstruction, that is at the pylorus from a scarred duodenal ulcer, or hypertrophic stenosis or carcinoma, or at the terminal duodenum from adhesions sometimes developing after gastro-enterostomy, congenital bands, etc. (2) Low obstruction, which is by far the most frequent and is located commonly at the ileocæcal valve or beyond; due to adhesions following operation especially after a ruptured appendix, a congenital band, strangulated hernia, carcinoma, etc. The pathology of each will be first discussed and treatment will be taken up later. Strangulation will be considered separately later on. Intestinal obstruction complicated by peritoneal infection as well as the so called paralytic ileus will not be included in the scope of the paper.

HIGH OBSTRUCTION

Persistent vomiting is a prominent symptom of high obstruction and comes on almost immediately after ingestion of food or liquid. The vomitus contains not only the fluid swallowed but gastric and pancreatic juice as well. These secretions often pour out in absence of any food intake and sometimes several liters may accumulate in a dilated stomach with very little actual vomiting. Distention is usually limited to the upper abdomen. Increasing weakness and prostration rapidly develop with the absence usually of much pain. The pulse grows weaker and faster, the skin becomes

[1] Read June 23, 1932, at a joint meeting of the Syracuse Academy of Medicine, the Onondago Medical Society, and Section N of the American Association for the Advancement of Science at Syracuse, New York.

drawn and dry, the sensorium depressed and coma and death supervene in a few days, if the patient is untreated and if the obstruction is complete. Because these changes occur more quickly and death more rapidly than is the case in low obstruction, it was for a long time assumed that the toxæmia was more severe the higher the occlusion.

We now know that in high obstruction the factor of toxæmia is of little or no significance. It may be of some interest to trace briefly the development of this advance. Hartwell and Hoguet of New York, in 1913, were the first to escape from the "toxæmia" theory by adducing evidence that death resulted from loss of water by vomiting. They made no studies of the blood. Haden and Orr, in 1923, reported low blood chlorides, but for a long time still clung to the idea of a toxin which combined with the chloride ion. They later gave up this idea. Our work began in 1926, when with Dr. McCaughan, I first reported that total loss of pancreatic juice was rapidly fatal (7). The symptoms were not unlike those seen after high intestinal obstruction. There was vomiting, weakness, fast pulse, prostration, shock and death usually within 7 days. We were unable to explain this rapid death until with Dr. Hartmann intensive studies of the blood chemistry were made (5). We found, briefly, that the experimental animals with pancreatic fistulæ showed the same changes as babies with severe diarrhœa, patients with duodenal or pancreatic fistula or high intestinal obstruction. These changes were those of anhydræmia, i.e. a high protein content often up to 11 per cent from a normal of 7 per cent, a low water content, indicating marked concentration of blood as shown also by a high hæmatocrit reading, a loss of base and chlorides, acidosis, and finally a rise of non-protein nitrogen. These changes can be explained on a purely chemical basis from the loss of water and salts in the drained pancreatic juice or in the vomitus in high obstruction. In other words, constant vomiting removes from the body not only water but the important salts of the gastric and pancreatic secretions which are normally reabsorbed to some extent from the intestine. The high non-protein nitrogen is probably due to the anuria, since the blood becomes too thick to pass the kidney capillaries.

Practical proof of the idea that we were dealing with purely chemical and physical changes was shown by the striking improvement in symptoms upon replacing the lost water and salts by means of intravenous injections of Ringer's solution which contains the common salts that are found in the gastric and pancreatic secretions. Animals moribund from loss of pancreatic juice could be brought back to life by the introduction of sufficient "combined solution," a modified Ringer's solution, which I will describe later. In subsequent experiments (6) with high intestinal obstruction and fistula we were also able to cure the so called "toxic" symptoms and prolong life by replacing the essential water and salts, lost in the vomitus, by parenteral injections.

These observations, with which most of you are by now undoubtedly familiar, are of course not characteristic of high obstruction. They are really due to loss of gastro-intestinal secretions from the inevitable concomitant vomiting. They apply equally to the profuse vomiting in infants from pyelitis, or other infections, in protracted hysterical vomiting where no gastro-intestinal lesion is present, in severe diarrhœa where the secretions pass through so quickly that no fluid is reabsorbed, and in high intestinal fistulæ. Indeed, if one minimizes vomiting in a high intestinal obstruction by withholding all fluid by mouth, symptoms are delayed and life is likewise prolonged.

Thus one can see that practically everything we know about the so called "toxæmia" of high intestinal obstruction can now be explained on purely physicochemical grounds. The loss of water and salts, in absence of absorption, drains the blood of water, base, chlorides, bicarbonate, etc., it becomes too concentrated for the peripheral circulation, local outlying acidosis (17) undoubtedly occurs, kidney function stops and death results. Replacing the lost water and salts dilutes the blood back to normal, peripheral circulation is re-established, kidney function begins, and the interchange between blood and tissues returns to normal.

LOW OBSTRUCTION

It was hoped for a time that this fruitful development of research in high obstruction could be used in cases of low obstruction. These hopes were only partially realized. We have seen that the key to our understanding of the pathology of high obstruction was the loss of gastro-intestinal secretions. In contrast to this, very slight loss usually occurs in low obstruction since vomiting is not apt to be a very prominent symptom. Indeed Dr. Hartmann and I have investigated the blood chemistry in ileocæcal as compared with duodenal obstructions in some detail (6). The blood changes in low occlusion were relatively slight and certainly not sufficient to explain death. This was true of both patients and experimental animals. Moreover, the administration of parenteral solutions influenced the symptoms but slightly and did not delay the inevitable lethal outcome.

There are other important differences. In high obstruction the course of the patient is progressively downward and can be correlated with the increasing dehydration of the blood. In low obstruction the so called "toxic" symptoms may not appear for days, even in the presence of distention which may be severe. Pain may also have diminished. The pulse rate may be normal and the blood pressure unchanged. Yet not infrequently sudden shock and death occur often within a few hours. At autopsy there is no perforation or other obvious cause for death. We have seen this phenomenon occur similarly in experiments on dogs. Pediatricians see it in infants with so called intestinal intoxication.

I have several times noted that suddenly deflating an enormously dilated bowel above a long standing obstruction may lead to a rapidly fatal outcome. This has also been the experience of others. Heusser and Schar cite the case of a 3 year old child who 4 months after operation for a ruptured appendix and while apparently well suddenly developed acute obstruction. At operation a single band was found occluding the distal ileum which was cut and the obstructed contents seen to pass into the healthy bowel, but 10 hours later the child was dead. The authors produced closed loops in rabbits. The distended bowel was opened in 24 hours whereupon the animals died within 10 minutes. We have seen the same phenomenon occur several times. The sudden access of obstructed fluid into normal bowel has been assumed to be the cause of sudden death but we have no evidence that any of the toxic material present in the fluid is absorbed from the normal intestinal mucosa. More likely, it seems to me, is the sudden release of tension in the distended bowel.

The key therefore to the pathology of low obstruction, in my opinion, is first the inevitable distention which it produces; second the effect of sudden release of tension. These two facts I shall consider in some detail.

Distention. Distention is an early and important symptom and sign and is due to the attempts on the part of the body to overcome the occlusion. Wave after wave of peristalsis, associated with the characteristic cramping pain, tries to break through the occlusion and succeeds only in dilating the intestine more and more to make room for the intestinal contents brought down and which cannot get through. The stagnation leads to increased bacterial action and the resulting gas produces an added force distending the gut still more. This leads to a vicious circle, for the increased pressure, at least up to a certain point, stimulates the secretory activity of the mucosa (16). Mucus as well as digestive fluids, therefore, are added to the volume of intestinal contents dammed back from the impassable lumen, and the wall stretches still more. Let us examine such an obstructed distended bowel. The contents are partly gas but mostly liquid, foul-smelling and very toxic, that is if injected intravenously into an experimental animal. This single fact has dominated much of the research on intestinal obstruction and, in my opinion, has beclouded the true state of affairs. We now know that normal intestinal contents are toxic. They contain active trypsin, peptones, phenols, amines and other substances besides gas bacilli and other bacteria which will kill on intravenous injection. To be sure the obstructed contents contain a much higher concentration of these toxic materials and bacteria. But one can introduce a liter of such fluid into the normal gastro-intestinal tract

and nothing serious occurs. On the other hand there is enough poison and bacteria in a few cubic centimeters of some normal intestinal contents to kill when injected into the circulation. So we see that it is not so much a question of demonstrating a poison in the mucosa, the wall, or the contents of the intestine, but rather of demonstrating whether it gets out, how it gets out and, of course, if it does, what its chemical or bacterial nature is. Attempts have been made, it is true, to demonstrate the absorption of a toxin. Sugito and Scholefield are the only workers who were able to kill mice with portal blood from obstructed dogs. But their results were not constant and were obtained with difficulty. We have had the same experience. Dr. Cole and I (1) have studied the thoracic duct lymph, portal blood and systemic blood from dogs sick of low intestinal obstruction by injecting the material into guinea pigs which are rather susceptible to toxic amines. We have not convinced ourselves as yet that toxin enters the circulation in abnormal amounts in low obstruction, though our studies are still in progress. We have also investigated the liver histologically and functionally (2) in obstructed dogs and although we have found definite and often marked impairment of liver function and histopathological changes, we do not believe that they are sufficient to have accounted for death, or to support the idea of a toxæmia. Recently Dodd, Minot and Casparis found guanidine, a very toxic substance, present in the blood of infants suffering from intestinal intoxication, a disease which many believe is related to obstruction. Dr. Senn and I have followed this idea and have in fact found a high blood guanidine in a few patients and in some dogs with low intestinal obstruction. Our observations are too few to permit general conclusions, but we have some evidence that amines other than guanidine may be present.

Sudden release of distention. It is not surprising, as a matter of fact, that it is so difficult to demonstrate a toxin outside the lumen of an obstructed intestine. We know from many experimental and clinical observations that distention of the bowel causes an obstruction of venous as well as lymphatic return. This distention is sometimes very great, great enough to cause gangrene especially of the wall opposite the mesentery where the circulation is the poorest. If this is true, distention obviously diminishes absorption. The most recent experimental work has shown that absorption above an obstruction is in fact very slight (12). But consider what occurs when such a distention is suddenly relieved. Circulation through the collapsed bowel is immediately altered. Absorption may be accelerated for one thing by the improvement in blood flow. Then, too, a large area of paralyzed capillaries may be opened for engorgement from the general circulation, thus leaving the systemic circulation poorer in blood and fluids. Such a possibility has been suggested by certain experiments that Dr. Cole and I have just made on the cause of death following acute occlusion of the portal vein (4) which, as is well known, is a rapidly fatal procedure. We have found that there is an astonishing accumulation of blood trapped in the splanchnic area following portal ligation which is sufficient to account for the symptoms of shock and probably death, from loss of blood and fluid alone. That is, enough blood is lost from the systemic circulation into the intestinal capillaries to lower blood pressure below that compatible with life. What application, if any, this has to the problem of low obstruction, cannot be said. We do know that the distention which occurs within the lumen of the intestines does actually produce a diminution or even a stoppage in portal outflow, sufficient sometimes to produce a gangrene of the bowel. Whether there is a sufficient escape of blood and fluid into the obstructed intestine to lower blood pressure and cause death we do not know. Further investigations, we hope, will give the answer. This is, of course, all purely speculative but the practical point is that something occurs when the distended bowel suddenly collapses which I believe is deleterious to the patient and may cause sudden death.

SLOW DECOMPRESSION OF DISTENDED BOWEL

Regardless of the mechanism of sudden death, I have attempted during the past year to avoid sudden release of distention by gradually decompressing the dilated bowel.

A mushroom catheter is placed into an obstructed loop and brought out through a separate stab wound so that the bowel lies in its natural position. The tube is clamped and released at frequent intervals so that drainage occurs progressively but slowly. Although the number of cases is still small the results were so striking I am tempted to report this procedure. It differs from the usual tube enterostomy which so often really fails to drain. It implies the minimum of operative trauma inasmuch as no attempt is made to cure the obstruction, unless of course a strangulation is present in which case the mass is exteriorized for later resection. It emphasizes finally the conservation of the distention as a protective measure for several hours until it is gradually and harmlessly relieved. Dr. Wangensteen, of Minneapolis, on a recent visit told me he has been treating his cases by passing a duodenal tube and draining the obstructed contents from above, and in 12 cases has seen remarkable improvement in "toxic" symptoms during the course of several hours. I believe his results are due to the slow gradual decompression of the distended bowel. Further observations of course are needed before one can prove such an assumption. I wish to report one very striking instance from my own cases.

A young negro was admitted to the St. Louis City Hospital with a history of several days' cramping pain and vomiting. A diagnosis of intestinal obstruction was made and operation advised but refused. He left the hospital but returned in 24 hours much more sick and with fæcal vomiting, dry skin, fast pulse, and more abdominal distention. Several liters of parenteral fluid were given and he was operated on under spinal anæsthesia with intravenous acacia-saline to maintain blood pressure, for his general condition was very poor. Both obstructed and collapsed bowel was seen after the abdomen was opened but little attempt was made to locate the obstruction, aside from satisfying myself that there was no strangulation. The obstructed gut was tremendously distended, bluish in color, and on mere contact the serosa and muscularis stripped off. A loop lying in the upper left quadrant was carefully mobilized and a Pezzar (mushroom) catheter was introduced and brought out through a separate stab wound. Every 30 minutes 100 cubic centimeters of fluid was allowed to escape from the tube by releasing the clamp. During this time parenteral fluids were continuously given. I considered the prognosis poor for this was the type of case which does poorly and usually dies within a few hours or a day after operation. I was astonished therefore to see a bright and cheerful patient the next morning with a flat abdomen, normal pulse and temperature. Several liters drained from the tube during the first 24 hours. He passed gas the following day and went on to a complete recovery. Two weeks later just before we were planning on X-ray studies of his gastro-intestinal tract he developed cramps and vomiting and was operated on soon after. The obstruction was found to be a band crossing the mid-ileum which was probably a remnant of the omphalo-mesenteric duct. It was cut. No further abnormalities were found. The wound was closed and the patient has been well since.

THE USE OF HYPERTONIC SALINE

I should like to mention briefly the use of hypertonic salt solution in intestinal obstruction, originally advised in order to furnish an abundance of chloride ions to neutralize the supposed toxin. Its physiological effect is now known to be quite different. It is a powerful stimulant of intestinal peristalsis (14) and is an efficient way of promoting evacuation of a paralyzed distended bowel which, after enterostomy, will not drain sufficiently. Without an outlet for the obstructed contents its use, of course, aggravates the distention quite as much as the use of purgatives.

THE USE OF HARTMANN'S SOLUTION

In the administration of parenteral fluids we have found of great value the modified Ringer's solution, as made up by Dr. Hartmann (9), of the Washington University School of Medicine. It is a physiological buffered solution containing in addition to calcium, potassium and sodium chloride, sodium lactate. This lactate, itself a calorogenic substance, on being oxidized yields bicarbonate which, slowly formed, directly combats any acidosis present and yet in the presence of alkalosis has no deleterious effect. The solution is made up in a concentrated form in ampuls and we add it either to distilled water or 5 per cent glucose and thus in one solution we have water, salts, buffer, and sugar. When mixed with the proper amount of distilled water it may be given subcutaneously or intravenously in the same manner as physiological saline solution. When made up in 5 per cent glucose, the intravenous route is the best. Its effect is really remarkable in

high obstruction or indeed in any case where marked dehydration from vomiting, fistula or diarrhœa is the important condition. Patients may be kept alive and with normal pulse and temperature for weeks by giving several liters of combined solution per day. In uncomplicated low obstruction it is beneficial in so far as dehydration is present, but of course is not specific or in general does not influence the progress of the disease without other means. The use of this "combined solution" while familiar to most pediatricians has been found by the surgical staff of Barnes Hospital to be a valuable addition to the surgical armamentarium because it seems to be more effective than ordinary saline and glucose. And here I might mention another point about the use of glucose alone. Glucose without saline dilutes the blood temporarily, stimulates renal excretion of salts, which finally leaves the blood much poorer than it was in both water and electrolytes. It therefore does decidedly more harm than good. Its use in conjunction with a solution containing salts, however, promotes diuresis and furnishes a source of needed calories.

CONSERVATIVE TREATMENT

All patients with intestinal obstruction receive several liters of combined solution at once. Gastric lavage is carried out. There is no objection in most cases to the use of a simple low enema to assist in ascertaining whether an obstruction is actually present. (The use of morphia occasionally relaxes a patient sufficiently to allow the obstruction to subside.) I believe one should not in general delay operation more than a few hours in the expectation of any spontaneous release of the obstruction. This, of course, does sometimes occur.

I remember the case of a young man whose ileum was perforated in several places by a bullet. The holes were all sutured. His postoperative course was smooth for 10 days when he developed acute obstruction for which it was found necessary to operate and a fibrous adhesion was found which was cut. He did well for 10 days and developed a second obstruction which was similarly treated and relieved. He balked, however, at operation when the third obstruction occurred for which he was being treated unsuccessfully by the usual conservative means. He left our care for another hospital. A few days later our resident called the other doctor who told him that the jolting he got in the ambulance coming out must have been pretty severe, for on arrival he asked for a bed pan and had a voluminous evacuation. He has remained well since.

We cannot hope for such miracles more than rarely, however, and the danger of increasing distention and with it the possibility of strangulation and gangrene from delay is too great to justify much procrastination. Operation should, therefore, be done within a few hours unless obvious improvement is in progress.

COMPLETE EVACUATION OF THE OBSTRUCTED BOWEL

Since some surgeons have recommended complete emptying of the obstructed bowel to get rid of the toxic contents, I should like to mention my experience with such an operation. The procedure is based on the idea that by removing the foul smelling poisonous fluid the toxæmia is averted. I have discussed already the toxæmia theory upon which this is based and the lack of proof that we are in fact dealing with a toxæmia. It is, moreover, impossible to remove all the toxic contents. Enough remains to kill several patients if absorbed. It is the absorption that is important and after doing the evacuation operation in several patients, I felt sure that absorption, if it occurs, was accelerated by the procedure. This is logical enough from the considerations already mentioned on the effect of the sudden release of distention. This is contrary to the report of Holden, who records a mortality of under 6 per cent in 135 cases of acute obstruction basing his low figure on the fact that he eviscerates the patient and systematically strips the bowel from the ligament of Treitz, emptying all contents down to the point of obstruction. This conclusion in my opinion is unjustified until we know the duration of the obstruction in his cases. Early cases do well no matter what we do, and his cases may have been for the most part early ones. In late cases too often a fatal outcome ensues no matter what is or is not done. It is moreover, physically impossible to do much stripping in the really late cases for any handling leads to tearing of the serosa and muscularis.

THE TREATMENT OF STRANGULATION

If a strangulated, and especially gangrenous, bowel is present the origin of symptoms is easy to explain and the exteriorization of the non-viable gut is obviously indicated. To resect immediately and to make an anastomosis carries a high mortality unless the duration of the disease is short—say 12 to 18 hours. Otherwise we have the dilated bowel above to consider; that is to say, the combination of strangulation and obstruction. To resect and anastomose, of course, removes the involved bowel and relieves the obstruction at the same time, but though the operation may be easily and quickly performed these patients, as already mentioned, too often die shortly after the operation from what I believe is a sudden release of distention. In the late cases, therefore, where the mortality is high, the non-viable bowel is simply exteriorized for later resection and plastic repair and the obstructed bowel above decompressed gradually by fractional drainage of its contents.

SUMMARY

The cause of death in untreated complete high obstruction (stomach and duodenum) is probably a physicochemical one, due to a depletion of water and salts from the blood into the vomitus or obstructed contents. The resulting dehydration can explain all of the so called "toxic" symptoms. Treatment with a modified Ringer's solution effectively restores the blood to normal, improves symptoms, and permits adequate surgical treatment without great risk.

The cause of death in low intestinal obstruction (ileum and colon) is probably different, but as yet there is little convincing evidence that a "toxæmia" is present. Distention plays a prominent rôle and the idea is expressed that sudden release of distention may be an important factor in the fatal outcome. The operative treatment has therefore been confined in the late cases to gradual decompression of the distended intestine, strangulated bowel being merely exteriorized for later removal.

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SURGICAL APPLICATIONS OF THE SCHILLING DIFFERENTIAL BLOOD COUNT[1]

JOHN S. HARTER, M.D., AND CHAMP LYONS, M.D., BOSTON, MASSACHUSETTS

THE newer methods of classifying white blood cells in a differential count provide the surgeon with information of both diagnostic and prognostic import. The differential count in common usage was described by Ehrlich in 1891. This classification has proved its usefulness in detecting gross abnormalities of the blood picture but time after time has failed to show significant changes even in the presence of severe infection. The inadequacies of the Ehrlich differential count have led to the development of classifications that propose to group the cells according to their age. Successful results have been obtained particularly with the polymorphonuclear neutrophils. Arneth's classification (3), first presented in 1904, listed over 80 cell types and consequently proved too complex for practical application in clinical problems. Schilling (19) in 1911 modified Arneth's original conceptions sufficiently to adapt such a scheme to laboratory routine.

Schilling describes only two types of cells in addition to Ehrlich's familiar groups but by doing so finds the advantage of listing granulocytes (polymorphonuclear neutrophils) according to their relative maturity. The two additional cells are the "juvenile" (*jungenliche*) and the "band" form (*stabkernige or "stab"*). The familiar polymorphonuclear neutrophil with its multilobular nucleus is designated a "segment." The classification of granulocytes in order of increasing maturity thereby becomes myelocytes, juveniles, bands, and segments.

Sufficiently accurate differential counts may be obtained by classifying 100 cells. With the blood smear prepared by the Wright stain[2] the cell types are recognized by Schilling as follows:

1. *Myelocyte.* The largest cell of the granulocytic series is spherical in outline with blue cytoplasm, usually containing fine granules. The nucleus is spherical and relatively large with fine chromatin network and several nucleoli.

2. *Juvenile.* This is a large cell, differing from the myelocyte in that its cytoplasm is a paler blue with slightly coarser granules. The nucleus is bean- or U-shaped, usually containing one or two circumscribed nucleolar condensations. The nuclear chromatin is slightly more condensed than in the myelocyte. This cell is almost identical with Pappenheim's description of the metamyelocyte.

3. *Band.* The cell is recognized by its rod- or band-shaped nucleus containing condensed chromatin, without nucleoli. The nucleus may take various forms, more frequently resembling the letters U, Y, S or T. In addition, it is necessary to recognize the so called *degenerative band*, with pycnotic, narrow, bizarre-shaped nucleus taking a darker or lighter stain than the typical band.

4. *Segment.* The segment is a mature polymorphonuclear leucocyte characterized by a chromatin thread connecting adjacent lobes of the nucleus. The nuclear chromatin stains similarly to that seen in the band form.

In recording the differential count the following scheme is used. In the column at the extreme right under the heading "Neutrophils" appears the total number of cells that are subdivided into myelocytes, juveniles, bands, and segments.

THE SCHILLING HÆMOGRAM

	WBC	Basophils	Eosinophils	Myelocytes	Juveniles	Bands	Segments	Lymphocytes	Monocytes	Neutrophils
Standard	7,000	1	2	0	0	4	64	23	6	68
Shift to left (regenerative)	10,200	0	0	2	12	35	41	9	1	90
Degenerative	3,500	0	1	0	0	25	28	40	6	53

An increase of juveniles and band forms, usually with an associated decrease of lymphocytes and monocytes, is described as a *shift to*

[2] The supravital method of staining the blood smear is undoubtedly the most accurate method of differentiating white blood cells. However, this highly specialized method requires so much time that it is hardly of clinical value to the surgeon.

[1] From the Surgical Laboratories of the Massachusetts General Hospital.

the left. Correspondingly, an increase of mature neutrophils usually with a restoration of lymphocytes and monocytes to normal or higher values, is known as a *shift to the right.*

A shift to the left with a graded increase of immature neutrophils is indicative of the active production or regeneration of white cells by the bone marrow, hence, this constitutes a *regenerative shift.* This is the characteristic picture with an acute infection and the degree of shift to the left may be directly correlated with the extent or severity of the infection. Diseases such as typhoid fever characterized by a leucopenia with neutropenia usually show a high percentage of degenerative band forms. This type of reaction is the *degenerative shift,* the extreme examples of which are encountered in certain infections with a low white blood cell count and agranulocytosis or malignant neutropenia.

Certain more or less physiological conditions are associated with a differential count that closely simulates a pathological blood picture. These must be kept in mind in interpreting a Schilling hæmogram just as in the usual differential count. We have found that the following conditions are most likely to cause confusion:

1. A leucocytosis with shift to the left accompanying muscular exercise and intense emotion.
2. Individual numerical variations according to age, constitution, and race.
3. A moderate increase in the white cell count and shift to the left may be present in uncomplicated pregnancy.

Most diseases and physiological conditions affecting the blood picture will fall in one of the following groups:

Neutrophilia without shift (neutrophils 70 per cent or over):

1. With increased white blood cell count.
   a. Physiological: digestion (?), slight muscular activity and emotion.
   b. Pathological: superficial minor infections, abortive cases of infectious diseases, hæmorrhage, chlorosis, polycythæmia, tetanus, malignant tumors (uncomplicated) and after sodium chloride infusions.
2. With normal or subnormal white blood cell counts:
   a. Physiological: changes dependent upon the uneven distribution of cells in peripheral and internal organs.
   b. Pathological: chlorosis (not constant), superficial minor infections, hæmorrhage, sarcomatosis, and malignant tumors (uncomplicated).

Neutrophilia with slight shift to left (Hyporegenerative, over 5 per cent bands):

1. The white blood cell count is usually increased but may be subnormal:
   a. Physiological: muscular activity, emotion and pregnancy.
   b. Pathological: mild infections, superficial minor or encapsulated septic processes that are not extending, bacterial endocarditis, protozoan diseases, syphilis, hæmorrhage, ulcerated tumors, lymphoblastoma, mildly active tuberculosis and tuberculous abscess formation.

Neutrophilia with marked shift to left (Marked regeneration with juveniles):

1. Usually with increased white blood cell count.
   a. Physiological: pregnancy, obstetrical labor and exercise.
   b. Pathological: acute infectious diseases, most of the acute protozoan diseases, acute and progressive septic processes, acute exacerbations of chronic infections and intoxications, as with carbon monoxide, heavy metal, and certain bacterial poisons.

Neutrophilia with extreme shift to left (Hyperregenerative, with myelocytes):

1. The white count may be increased, normal, or decreased.
   a. Physiological: not found.
   b. Pathological: occurs in the most severe cases of sepsis and in disease or injury of bone marrow.

Neutropenia (Absolute diminution of the neutrophils):

In these conditions the total number of

APPENDICITIS

	WBC	B	E	M	J	B	S	L	M	N
Standard	7,000	1	2	0	0	4	64	23	6	68
1. Chronic appendicitis	14,000	0	0	0	0	10	57	29	4	67
2. Acute appendicitis	10,000	1	1	0	2	9	37	45	5	48
3. Acute appendicitis	8,500	0	1	0	1	15	66	15	2	82
4. Acute appendicitis with peritonitis	10,300	0	0	0	4	37	47	7	5	88

In appendicitis the degree of shift to the left in the Schilling hæmogram has been found to correlate with the severity of the infection as judged by clinical standards with greater constancy than either the total white blood cell count or the Ehrlich differential count (9, 21).

POSTOPERATIVE COURSE OF ACUTE APPENDICITIS WITHOUT COMPLICATIONS, APPENDECTOMY WITHOUT DRAINAGE

	WBC	B	E	M	J	B	S	L	M	N
Standard	7,000	1	2	0	0	4	64	23	6	68
Pre-operative	8,500	0	1	0	1	15	66	15	2	82
2nd day postoperative	11,000	0	0	0	0	12	72	15	1	84
3rd day postoperative	11,000	0	0	0	0	2	74	24	0	76
5th day postoperative	7,800	0	4	0	0	5	51	37	3	56
7th day postoperative	8,300	0	1	0	0	5	62	29	3	67
9th day postoperative	13,000	2	3	0	0	4	66	22	3	70

There is a decrease of the bands to slightly below normal and a moderate lymphocytosis usually accompanied by a slight monocytosis during the normal postoperative course of a drained or removed focus of infection. The white blood cell count may increase or decrease slightly following operation. The degree of shift reflects the progress of the patient more accurately than does the total leucocyte count.

neutrophils is reduced. The leucopenia with bands and often a degenerative nuclear shift is due to reduced activity of the neutrophilic centers in the bone marrow. This picture occurs most frequently in the presence of typhoid fever, epidemic parotitis, Malta fever, grippe, chicken pox, acute poliomyelitis, sympathetic ophthalmia, and occasionally in tuberculosis.

In order to evaluate the practical usefulness of the Schilling differential count the hæmogram was made a part of the routine blood examination on cases of sepsis admitted on the West Surgical Service of the Massachusetts General Hospital. These studies were performed in the routine laboratory by surgical internes without unusual training in hæmatology. A few cases typical of common types of sepsis are recorded below to illustrate the clinical application of this method of blood examination.

INTERPRETATION OF THE SCHILLING HÆMOGRAM

The complete interpretation of the Schilling hæmogram takes into consideration the distribution of the lymphocytes, monocytes, eosinophils, and basophils as well as the types of neutrophils. The monocytes and eosinophils are decreased in number in advancing acute infections of surgical importance. In infection the number of lymphocytes has been found to reflect the resistance of the individual (12). Low lymphocyte counts occur particularly with advancing acute infections in patients with poor resistance. Normal or high lymphocyte count in the presence of a shift to the left is an indication of good resistance, as seen in localized sepsis or chronic infection. The disappearance of neutrophilia in recovery is associated with slight elevation of lymphocytes and monocytes. A transient basophilia has been noticed in postoperative leucocytosis.

The evaluation of the total white blood cell count on the basis of the types of neutrophils present is an index of the reaction of the individual to infection. An increasing shift to the left with a rising white blood cell count occurs when the individual shows an adequate response to the increased demand for white blood cells. An increasing shift to the left in the presence of a falling leucocyte count occurs with the inability of the individual to meet the

POSTOPERATIVE COURSE OF ACUTE APPENDICITIS WITH PULMONARY COLLAPSE AND PERITONITIS; APPENDECTOMY WITH DRAINAGE

	WBC	B	E	M	J	B	S	L	M	N
Standard	7,000	1	2	0	0	4	64	23	6	68
1st day postoperative	10,300	0	0	0	4	37	47	7	5	88
3rd day postoperative	8,000	0	0	4	8	44	34	8	2	90
4th day postoperative	pulmonary collapse, clinically									
5th day postoperative	4,330	0	0	2	7	51	17	14	9	77
6th day postoperative	5,650	0	0	2	7	43	15	27	6	67
7th day postoperative	5,900	0	1	1	5	49	19	22	3	74
8th day postoperative	10,100	0	1	0	4	53	19	16	7	76
9th day postoperative	16,200	0	0	0	5	53	33	6	3	91
10th day postoperative	drain removed from abdomen									
11th day postoperative	18,000	0	0	0	0	29	49	18	4	78

A pre-operative differential white blood cell count was not obtained in this case but the decreasing white blood cell count with increasing shift to the left suggested a complication. The pulmonary complication was reflected in the hæmogram before the development of clinical signs. The increasing white blood cell count after the fifth day suggested improvement but the persistence of the shift to the left indicated residual infection. When the drain was removed from the abdomen on the tenth day about 15 cubic centimeters of pus drained from the sinus. The increase in the white blood cell count with a shift to the right the next day coincided with the subsiding infection.

APPENDECTOMY IN THE PRESENCE OF PREGNANCY

	WBC	B	E	M	J	B	S	L	M	N
Standard	7,000	1	2	0	0	4	64	23	6	68
Pre-operative	14,700	0	1	0	0	16	56	19	8	72
3rd day postoperative	12,600	1	0	0	0	8	80	10	1	88
10th day postoperative	18,500	0	2	0	0	15	52	31	0	67

Pregnancy without complication may give a blood picture simulating that of a pathological shift. This patient clinically, presented pain in the right lower quadrant. There was no elevation of the temperature. The hæmogram did not help in the differential diagnosis. There was no evidence of acute infection at the time of operation.

DEEP SEPSIS OF THE SCALP

	WBC	B	E	M	J	B	S	L	M	N
Standard	7,000	1	2	0	0	4	64	23	6	68
Pre-operative	17,100	0	0	5	19	54	21	1	0	99
1st day postoperative	7,500	0	0	0	10	54	21	13	2	85
3rd day postoperative	7,500	0	0	0	1	22	67	10	0	90

The presence of myelocytes with the low lymphocyte count denoted a severe infection with poor resistance on the part of the patient. However, a prompt shift to the right and an increase in lymphocytes followed drainage of the infection. A favorable prognosis was given the first day after operation that was well borne out by the subsequent clinical course.

GANGRENE OF FOOT WITH INFECTION, AMPUTATION

	WBC	B	E	M	J	B	S	L	M	N
Standard	7,000	1	2	0	0	4	64	23	6	68
Pre-operative	6,200	0	0	8	65	3	2	22	0	78
2nd day postoperative	7,000	0	0	3	19	29	27	22	0	78

The presence of myelocytes and a large number of juveniles again is associated with a severe infection. A good prognosis was given the second day after amputation because of the shift to the right. The Ehrlich differential count shows only a slight decrease in the myelocytes after operation, while the total number of neutrophils is the same before and after operation. The change in the total white blood cell count is also insignificant.

RHEUMATIC FEVER SIMULATING OSTEOMYELITIS (NO OPERATION)

	WBC	B	E	M	J	B	S	L	M	N
Standard	7,000	1	2	0	0	4	64	23	6	68
On admission	11,400	0	0	0	0	7	55	32	6	62
4th day in hospital	10,500	1	3	0	0	2	57	33	4	59

A boy of 12 years was admitted with a swollen, red, tender area over the distal end of the left tibia. There was a less pronounced process in the same region on the right side. Clinical observations suggested osteomyelitis. The hæmogram showed only a slight lymphocytosis without shift to the left, a picture absolutely inconsistent with pyogenic infection particularly in a patient of this age.

demand for white cells. Insufficient response to the infection is seen in the cases of hyperregenerative shift without leucocytosis. The decreased demand for white cells in subsiding infections results in an increase of the mature neutrophils and a shift to the right. This shift is frequently seen with a temporary elevation of the white blood cell count as the blood returns to normal.

The progress of a patient with an infection may be very accurately followed by frequent hæmograms and white blood cell counts. However, adequate surgical treatment may quickly alter the blood picture and therefore the prognosis.

USE OF THE HÆMOGRAM IN OTHER CLINICS

Results similar to these have been obtained in surgical cases in other clinics. Baum has taken the hæmogram as a true picture of organ pathology and has emphasized the value of repeated counts. He considers it a thoroughly reliable diagnostic and prognostic aid. Reznikoff is in accord with this viewpoint and feels in addition that changes in the hæmogram may antedate clinical symptoms. Yaguda, in a study of 671 cases of appendicitis, was able to correlate the degree of shift in the hæmogram with the extent of the infectious process. This was also true in the 40 cases of appendicitis reported by Goodale and Manning. No shift was present in those cases in which normal appendices were found.

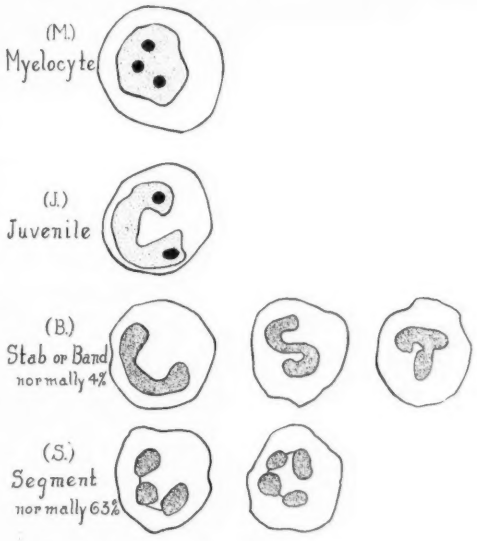

Fig. 1. Schematic representation of granulocytes as classified by the Schilling differential blood count. (After drawings by Miss Muriel McLatchie.)

CONCLUSIONS

1. The Schilling differential count is readily adaptable in routine laboratory usage to replace the Ehrlich differential blood count.

2. It is of more value than the Ehrlich differential count in detecting the presence, degree, and persistence of infection.

3. The Schilling hæmogram is the simplest classification of neutrophils giving an adequate picture of the bone marrow response to infection.

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CLINICAL SURGERY

FROM THE LAHEY CLINIC

THE SURGICAL MANAGEMENT OF VERY SMALL AND EARLY PULSION ŒSOPHAGEAL DIVERTICULA

FRANK H. LAHEY, M.D., F.A.C.S., BOSTON, MASSACHUSETTS

IN our experience in performing the two stage excision of pulsion diverticula of the œsophagus in some 35 patients with no deaths, we have been impressed with the fact that the fair but intermediate sized type is the easiest to manage surgically; the diverticulum with a sac large enough to be readily mobilized and implanted in the wound with the dome well above the level of the skin, is the simplest type to operate upon (Figs. 1 and 2).

Very large œsophageal diverticula are often difficult to handle surgically, particularly since patients with them are often bad risks because they have not received sufficient amounts of food on account of the long-standing obstruction; in addition the aperture made by the opening of the diverticulum at its neck is often so large that dissection, particularly on the right side, may be somewhat troublesome (Fig. 2).

We have no real difficulty in treating large and intermediate sized diverticula by the two stage operation. On the other hand, at the beginning of our experience we hesitated to operate upon patients with small sacs which were of insufficient diameter to permit the dome to reach above the level of the skin when implanted in the wound. With added experience, however, we have developed a plan whereby even the smallest diverticulum can be taken care of by the two stage procedure, provided it is of sufficient size to have developed a sac with a distinct neck. We have operated upon several patients with extremely small œsophageal diverticula by the two stage plan, quite safely and satisfactorily; the X-ray of one which has just been successfully operated upon is shown in Figure 3.

In our opinion, it is a real advantage to be able to operate while the diverticulum is still small. Because of the technical difficulty presented by such diverticula, there has been a distinct tendency to postpone operation until the sac has increased in size. This often results in the patient's undergoing for an unnecessary length of time the discomforts associated with a sac of considerable size, such as regurgitation of food, partial obstruction, and—as has happened in a few of the cases upon which we have operated—interference with sleep, due to the accumulation of fluid contents in the sac during slumber, the contents running through the glottis into the trachea and producing attacks of choking. In 2 patients this has been one of the urgent symptoms which has prompted the seeking of relief, and cases suffering from this complication should, we believe, be immediately submitted to surgical removal of the sac by the plan mentioned.

There has been some disagreement in the literature as to the wisdom of removing œsophageal diverticula by the one stage or two stage operative plan. As the result of our successful experience with the latter procedure, as stated, we do not feel like changing our method. We believe that in any large series of diverticula removed by the one stage plan there is almost certain to be an occasional one in which leakage will occur, followed by mediastinitis and a fatality.

Dissection of œsophageal diverticula so that the entire neck of the sac is free and can be mobilized upward is at times difficult and requires meticulous technical precautions. Suture of the œsophagus on its posterior wall deep in the wound behind the trachea is of necessity difficult, particularly since it must be done close to the pharynx where the œsophagus disappears beneath the lowest fibers of the inferior constrictor. The œsophagus ascends and descends constantly with swallowing. The œsophageal canal is always infected, and must therefore be in constant danger of leakage. We admit that with the accurate application of stitches sacs can doubtless be removed in one stage, the neck of the sac sutured, and the occurrence of non-fatal leakage usually prevented. Unfortunately, however, the situation is similar to that in all sutures of the alimentary canal:

Fig. 1. This roentgenogram shows the moderate sized sac, the ideal size for the two stage operation.

Fig. 2. This shows the very large sac in which two stage operation is very easy because the dome of the sac can be implanted well above the level of the skin but the dissection may be difficult due to the size of the aperture into the longitudinal œsophagus.

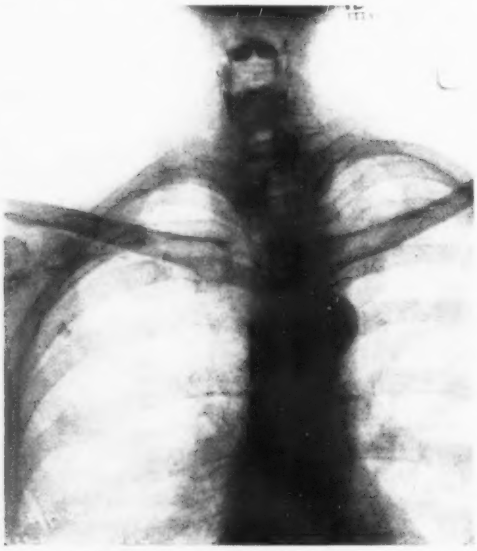

Fig. 3. This is the very small sized diverticulum concerning which this paper is written. This sac is about the size of a grape. It was in this type that up to the time of the development of this plan, operation was delayed until the sac had reached greater diameter.

through technical errors and inaccuracies—and they will occur in the very best of hands—through necrosis secondary to local loss of blood supply, through inaccurate application of stitches, or through too tight ligatures, with pulling of stitches, leakage in any intestinal or œsophageal suture will occasionally happen in spite of the most painstaking attention to details. Leakage in œsophageal diverticula operations is into a fascial plane, which is admittedly a dangerous one; this plane is represented in back by the prevertebral fascia, and in front by the pretracheal fascia, and leads directly into the mediastinum. Infection occurring along it can usually be controlled by drainage, but occasionally a fatal mediastinitis will occur in spite of it.

We feel strongly, therefore, that the two stage procedure, in which, provided the sac is not opened there is no danger of dissemination of infection along the fascial plane, with consequent mediastinitis, is to be preferred, even though it may seem less surgical, and that it will in a large series of cases result in a lower mortality. As we have repeatedly stated, if one out of one hundred patients operated upon by the one stage plan died as the result of leakage, but none of an equal

number operated upon by the two stage plan, we should consider this a convincing argument in favor of the latter.

With this in mind, we have been greatly interested in developing a method whereby even the smallest sac can be safely operated on by the two stage plan, thus permitting early relief from distressing symptoms, and in all probability producing local conditions in the œsophagus which will bring better postoperative results. The œsophageal diverticulum shown in Figure 3, for example, is about the size of a small grape. It was nevertheless successfully removed by the two stage procedure.

The surgical approach to the small pulsion œsophageal diverticulum is exactly the same as that we have described for the large diverticulum. An incision is made either transversely above the clavicle or longitudinally in front of the sternomastoid. The belly of the omohyoid is cut, the middle thyroid veins are ligated, and the lobe of the thyroid is turned forward. The inferior thyroid artery will seldom need to be ligated when the sac of the diverticulum is small. The sac is readily found under regional anæsthesia by asking the patient to swallow, when it may readily be seen to ascend and descend in the wound (Fig. 4).

The sac is picked up with tacking forceps, and is carefully dissected from the overlying fibers of the cricopharyngei muscle until it is entirely free at the top, on the right side, at the bottom, and on the left side. When the diverticulum has been completely freed, as it can be with adequate exposure and retraction, so that the lower angle made between the diverticulum and the longitudinal wall of the œsophagus is entirely freed, the dome of the sac is gently lifted upward and approximated to the outer edge of the sternohyoid muscle at a point such that the dome of the sac is higher than the point at which the neck of the sac joins the longitudinal œsophagus. Two black silk stitches, as shown in Figure 5, are then passed through the submucosa of the sac and the outer edge of the sternohyoid muscles. Care is taken to make certain that these silk stitches penetrate only the submucosa and do not pass through the mucosa. If they pass through all the coats of the diverticulum, they may easily cut out of the sac as the result of vomiting or swallowing, with consequent leakage and infection within the fascial plane. With the dome of the sac fixed between the first and second stage operations to the sternohyoid muscles at a higher level than the neck of the sac, there will be no accumulation of material within the sac, the patient will be able to swallow immediately with no regurgitation, and the distressing regurgitation of food into the larynx during sleep spoken of previously will no longer occur.

With the sac sutured to the prethyroid muscles, a cigarette drain is placed in the lower angle of the wound, so that granulations and adhesions will occur behind the œsophagus in the fascial plane made by the prevertebral fascia in back and the pretracheal fascia in front, thus guarding the patient against mediastinitis at the second stage operation. The wound is then closed by interrupted sutures and the sac is thus left completely buried in the wound fixed as it is to the sternohyoid muscle.

Following this stage, patients swallow without difficulty, can be out of bed the day after operation, since it is done under novocain cervical block, are immediately relieved of all symptoms of obstruction and regurgitation, and may possibly go on indefinitely without difficulty in swallowing even if the second stage removal of the sac is not done. The second stage removal is, however, safe and simple; there is always the possibility that the sac may dilate, and for that reason the removal should be done.

At the end of 10 days the wound is reopened. The sac is readily discovered by following the edge of the sternohyoid muscle up to the point where the two black silk stitches which attach the sac to it are located. These stitches are cut, and the sac drops away from the muscle and is immediately available for removal.

We have had no difficulty in the sac's pulling away from the sternohyoid muscle between stages, no matter how small it was. The œsophagus is lax; it readily dislocates to one side, and any tension on the sac of the diverticulum, no matter how small, is, we think, readily compensated for by rotation of the œsophagus and by lateral dislocation of that structure to the side on which the diverticulum sac is sutured.

With the sac of the diverticulum freed at the second stage, two tacking forceps, as shown in Figure 6 are placed upon the dome of the sac, traction is made upon it, and the neck of the sac is freed of adhesions and demonstrated. An incision with a knife is then made about the neck of the sac, as shown in Figure 6, through the submucosa and what remains of muscularis, down to, but not through, the mucosa. This incision is carried around the entire neck of the sac, a ligature of fine chromic catgut is then tied about the neck of mucosa, the sac is cut away, the stump of mucosa is cauterized, a cigarette drain is carried down to the stump of mucosa as in an appen-

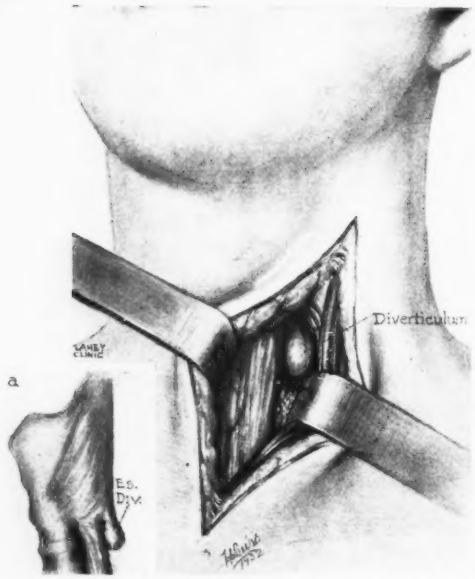

Fig. 4. The main illustration shows the small sized sac dissected free and resting in the wound. Insert a shows diagrammatically the size of the small sac.

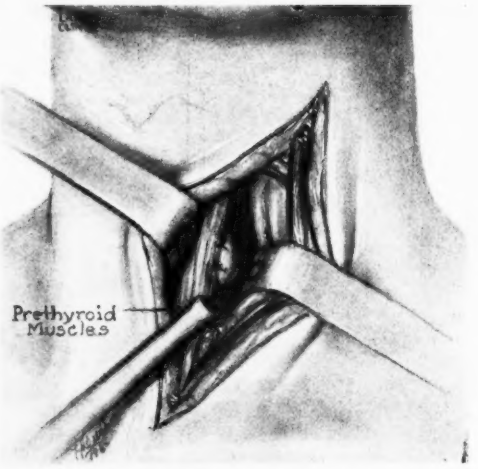

Fig. 5. This illustration shows the dome of the sac dissected free and sutured with two black silk stitches to the edge of the sternohyoid muscle to fix it at this point. The wound is then closed so that the sac is buried in the wound. At the end of 10 to 12 days, the wound is reopened. The sac can then readily be discovered by following the edge of the prethyroid muscles and demonstrating the two silk stitches which attach the sac to it.

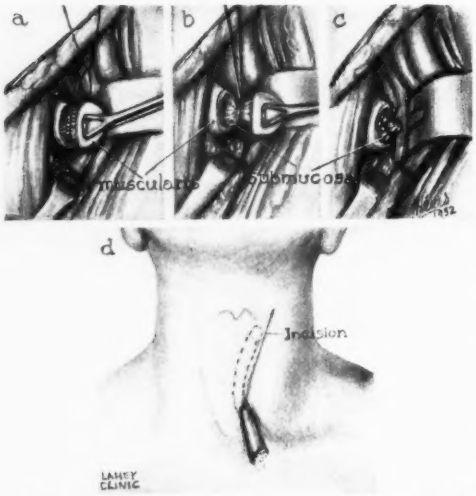

Fig. 6. In insert a the sac has been detached from the sternohyoid muscle. The submucosa has been incised and a ligature passed around the mucosa lining the diverticulum. In insert b this has been tied. In insert c it has been cut away as in appendectomy. In insert d a drain has been carried up to the point of ligature and emerges from the lower angle of the wound. The wound has been closed in layers about the drain.

dectomy, and the wound is closed about the drain. This procedure has resulted in little or no leakage, and patients have usually been able to leave the hospital within 8 to 10 days following the second stage removal.

We have been interested in developing this plan of operating upon small pulsion œsophageal diverticula because of our conviction that any patient with this condition will show constantly increasing size of the diverticulum the longer he continues with it. With increase in size will come increase in symptoms, likewise lengthening years with the patient less able to withstand surgical operation. The average age of the 35 patients operated upon for pulsion œsophageal diverticula was 58½. The youngest was 42 and the oldest 8

As stated in all our earlier discussions, patients who have been operated upon for pulsion œsophageal diverticulum should be bougied after operation at invertals of 2 to 3 months for at least a year, regardless of whether procedure has been by the one stage or two stage plan. One of the logical theories of the origin of œsophageal diverticulum attributes it to spasm and obstruction of the cricopharyngei muscle fibers at the pharyngo-œsophageal junction. Furthermore, whether the neck of the diverticulum be closed by a one stage or two stage procedure, there will

be some scarring on the posterior wall of the œsophagus. It is, therefore, desirable and not particularly disturbing to patients to pass olive-tipped bougies by the point of closure at the pharyngo-œsophageal junction for the period indicated in order to dilate the œsophagus itself at this point and overcome any persisting spasm of the cricopharyngei muscle fibers.

No patient should be dilated by bougie after œsophageal diverticulum operations unless he has previously swallowed a string so that the bougie may be accurately guided by the point of suture. Patients are given a spool of No. 7 or No. 9 silk and instructed to swallow at least 10 feet, starting the day before they are to come for bougieing. Olive-tipped bougies on a whalebone carrier are then threaded upon the swallowed string, the string is wrapped around the finger of the person passing the bougie and stretched, when the bougie readily passes the point in the œsophagus from which the diverticulum was removed and into the longitudinal œsophagus. Unless this method of bougieing upon a string guide is employed, it is possible to engage the bougie against a shelf of œsophageal mucosa and do damage by forcible pressure.

CONCLUSIONS

1. It is undesirable that patients be compelled to put up with the symptoms of pulsion œsophageal diverticulum until it has reached such a size that it can be implanted well above the level of the skin.

2. Pulsion œsophageal diverticula do not disappear, but tend to increase in size and to produce more and more marked symptoms.

3. It is desirable to remove pulsion œsophageal diverticula, no matter how small they are, provided that they have produced a sac with a distinct neck.

4. The sac may be implanted in the wound and safely removed by the two stage procedure without the danger of leakage and mediastinitis.

5. It is desirable, regardless of whether removal is by the one stage or two stage procedure, that patients be bougied after operation every 2 to 3 months for a year, and that the bougie be passed upon a string guide.

FROM THE UNIVERSITY OF ROCHESTER SCHOOL OF MEDICINE

THE OPERATION FOR PERFORATIONS OF THE CERVICAL ŒSOPHAGUS

HERMAN E. PEARSE, JR., M.D., ROCHESTER, NEW YORK
From The Department of Surgery, The University of Rochester School of Medicine and Dentistry, Rochester, New York

PERFORATION of the œsophagus endangers life from infection of the mediastinum. This holds true irrespective of the location of the perforation, whether cervical or thoracic. Extravasation from the thoracic portion allows direct contamination of the mediastinal structures with such a virulent infection resulting that few patients have the resistance to survive. Efforts at surgical relief have been disappointing.

On the other hand the mediastinitis following cervical perforation is an indirect effect. It results from a dependent spread of infection from the neck into the chest along the fascial spaces. There is abundant evidence to prove that a direct communication exists between the cervical region and the mediastinum (1). This is due to the fact that during embryological development the mediastinal structures originate in the neck and migrate into the chest carrying their enveloping fascia with them. The conception that the mediastinum begins at the diaphragm and ends at the base of the skull (5) is logical since at no place is there a transverse demarcation to segregate these regions. The blocking of the paths of communication between chest and neck effectively separates the parts. If this is done before the infection has gravitated to the mediastinum then mediastinitis is prevented.

In the controversy that has arisen among endoscopists as to whether infection should be drained through the endoscope or by an external incision, it would appear that this fact has been lost sight of. There is no doubt that a localized abscess beside the cervical œsophagus can be drained by the œsophagoscope. But who feels competent to predict that the infection will localize and not spread into the mediastinum? Should the œsophagus be exempt from the rules, which experience has dictated, for early surgical intervention in case of perforation of other organs, as from peptic ulcer, an inflamed appendix, or a traumatized urethra? It should be kept in mind that the patient does not die of the perforated cervical œsophagus, *per se*, nor does he necessarily die from the infection in the neck but usually dies from mediastinitis, the indirect result of the perforation. It is possible for the surgeon to do what nature has left undone, namely to create a transverse barrier between the neck and the chest. Thus the external operation for perforation of the cervical œsophagus will have a two-fold purpose, first to block the fascial spaces to the mediastinum and second to evacuate extravasated material.

The operation designed for this purpose was originally described by Marschik. This procedure which has not been modified to date consists of two parts. After a long incision is made parallel to the anterior border of the sternocleidomastoid muscle the space, low in the neck, between the carotid sheath and the trachea, œsophagus, and thyroid gland is packed with gauze. This space is called the anterior cervical mediastinum. The dissection is carried upward, the omohyoid muscle is cut and the so-called posterior cervical mediastinum is reached. This space is between the vascular sheath laterally, the prevertebral fascia posteriorly, and the œsophagus, trachea, and superior pole of the thyroid gland medially. This space is packed and any extravasated material present is drained.

Palmer describes the Marschik operation as he learned it in Hajek's clinic in Vienna as follows: An incision is made from the mastoid to the sternum. The sternocleidomastoid muscle is retracted "until the vascular sheath is reached." This is called the anterior cervical mediastinum and is tamponed with iodoform gauze. The dissection is carried upward, the omohyoid is cut and "by gently lifting the thyroid forward with blunt retractor, the posterior cervical mediastinum is reached. The index finger may now be inserted until the cervical vertebræ are encountered." This area is tamponed and the original source of the infection is sought if the operator desires. The same description is given by Keiper (3). No mention of the operation was given in the modern textbooks or systems of surgery or otorhinolaryngology that were consulted.

The operation as originally performed in his clinic differed in a few details but not in essential principles. A smaller incision was used either transverse or parallel to the anterior border of the sternocleidomastoid muscle just above its cla cu-

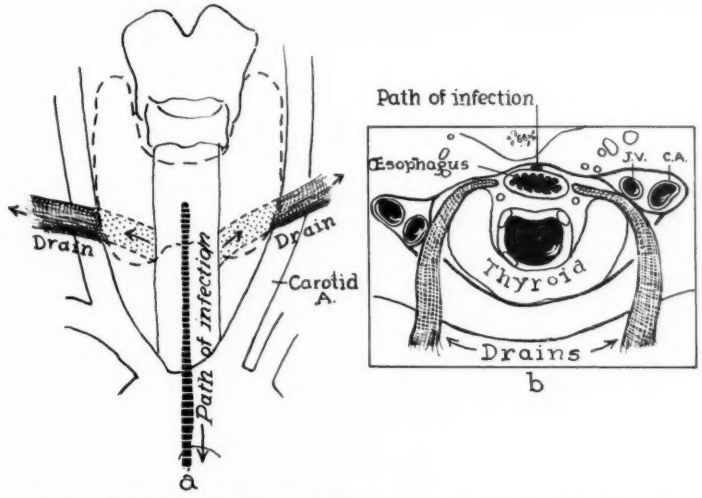

Fig. 1. A diagrammatic front and cross section, b, view from a case in which the standard operation was done but where infection gravitated to the mediastinum behind the œsophagus. This and a similar case demonstrated the necessity of blocking the post-œsophageal space.

lar attachment. The omohyoid muscle was not cut. The space between the carotid sheath laterally and the trachea, thyroid, and œsophagus was packed down to the vertebral column in the accepted manner. The carotid sheath was occasionally opened and drained.

After several years' experience with this operation it became evident that it had two defects. The first of these is that the packing above the level of the omohyoid in the posterior cervical mediastinum of Marschik was too high. The primary purpose of this packing is to create a barrier against the spread of infection into the mediastinum. By placing it so high in the neck it is conceivably possible to block the space *above* the point of perforation and hence do nothing to prevent dependent drainage. But exposure of this space at a lower level is difficult because of the interposition of the thyroid gland. The obvious solution for anyone familiar with the technique of thyroid surgery is to mobilize the gland by freeing its lateral vascular attachments and turn it medially out of the way. This mobilization of the thyroid gland allows the lowest possible packing and disposes of the first objection.

The second fault in the original Marschik procedure was discovered by postmortem dissection in two cases. In one of these the operation was done but despite this the patient developed mediastinitis and died. At autopsy it was found that the infection had tracked down *behind* the œsophagus (Fig. 1). A second patient who had a posterior perforation died without operation from mediastinitis. Dissection revealed no infection of the spaces which would have been packed at operation but instead a small tract of infection going down immediately behind the œsophagus. From the experience with these 2 cases it was decided that the Marschik operation was incomplete in so far as the space behind the œsophagus was not blocked. Furstenberg has pointed out the direct communication of this space with the mediastinum.

TECHNIQUE

The operation, as it is now performed, is as follows: A 3 inch incision is made parallel to the clavicular attachment of the anterior border of the sternocleidomastoid muscle. This muscle is identified and retracted laterally after incision of the superficial cervical fascia. The dissection is carried down to the carotid sheath, the fascia and muscle fibers of the sternohyoid and sternothyroid muscles are separated, and the lateral surface of the thyroid gland is exposed. It is usually found that the gland is held down by the middle thyroid vein (Fig. 2). After ligation and division of this attachment the thyroid gland is rotated medially (Fig. 3). This may be all that is needed to expose the œsophagus. In some instances the inferior thyroid artery may limit the retraction of

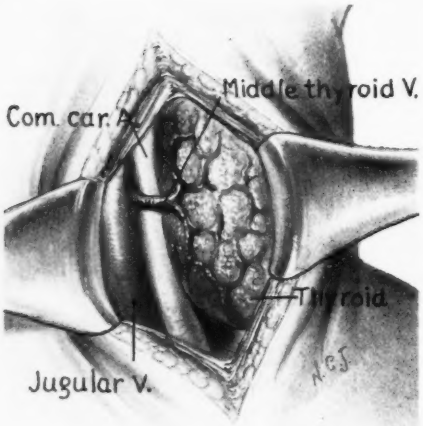

Fig. 2. The exposure of the lower cervical œsophagus is usually prevented by the lateral vascular attachments of the thyroid gland.

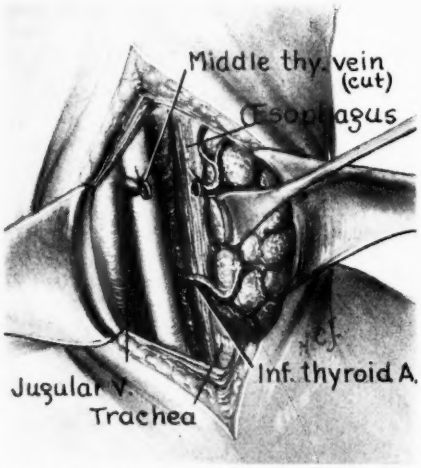

Fig. 3. The division of the middle thyroid vein and if necessary of the inferior thyroid artery permits the medial retraction of the thyroid gland. The dissection should be kept as low as the manubrium and clavicle permit.

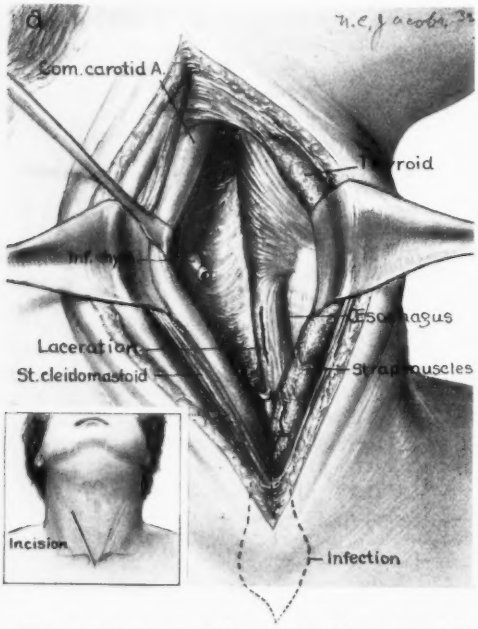

Fig. 4. A drawing made from a case of laceration of the œsophagus from a clam shell which shows the exposure obtained. For clarity the drawing is made with a larger incision than that actually used (insert). The operative incision was lower and its upper angle was level with the top of the laceration. The dotted line shows the limits of dependent spread of infection. The patient recovered.

the thyroid gland. If this occurs, the artery is doubly ligated and divided at its point of emergence from beneath the carotid. The thyroid gland may then be rotated medially and a free exposure of the œsophagus obtained, illustrated by Figure 4, which is made from a case operated on 40 hours after perforation of the cervical œsophagus, with recovery.

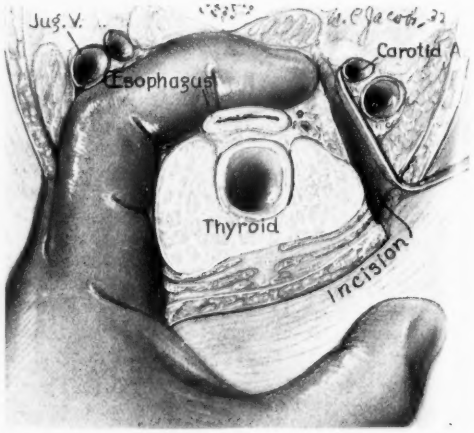

Fig. 5. A cross section which illustrates how the finger is inserted behind the œsophagus to allow packing of the post-œsophageal space. A bilateral incision is shown but if the process is limited to one side of the neck a single incision is used.

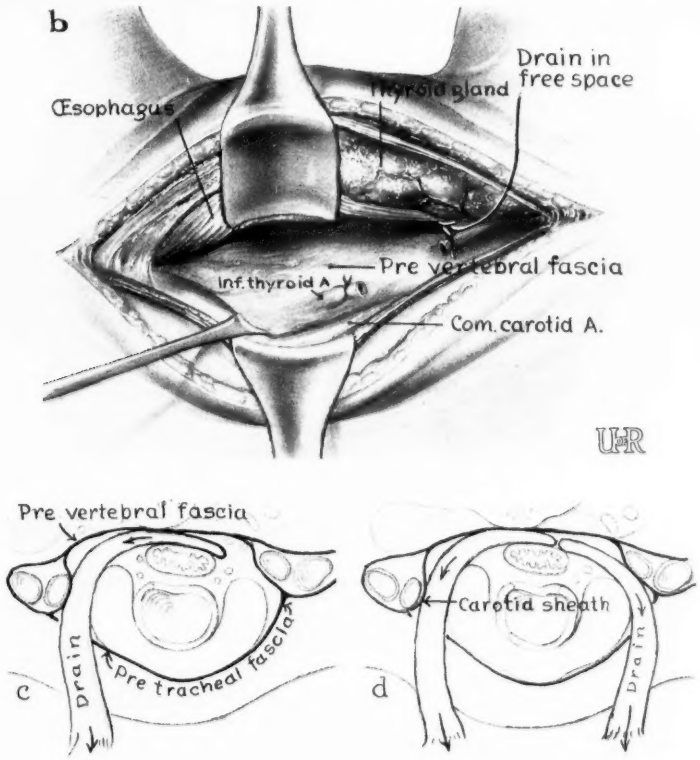

Fig. 6. b, A side view of a dissection on a cadaver to show the potential space existing behind the œsophagus. The obliteration of this space by packing (arrow) prevents dependent drainage. c and d are diagrammatic cross sections to show the position of the packing with unilateral and bilateral incisions, respectively.

After the structures have been exposed in this manner the finger is gently inserted behind the œsophagus to separate it from the prevertebral fascia (Fig. 5). This is surprisingly easy since there is only filmy areolar tissue in the post-œsophageal space. The tip of the finger is carried beyond the œsophagus to the opposite side. Gauze or a drain is then inserted with the tip extending beyond the œsophagus and brought out behind this structure then lateral to it and to the trachea and thyroid gland and medial to the carotid sheath and sternocleidomastoid muscle. If the symptoms are referable to only one side of the neck, then the operation may be terminated. If bilateral involvement is apparent, then a similar incision to that already described is made on the opposite side and a drain is inserted down to meet that already placed. This serves to pack the fascial spaces beside and behind the œsophagus and effectively blocks all paths of spread to the mediastinum (Fig. 6).

This operation is done under local anæsthesia by regional block of the cervical nerves at the posterior border of the sternocleidomastoid muscle. A small amount of intracutaneous infiltration may be used in the line of the skin incision. The procedure does not cause shock and should involve less risk than the average operation for goiter. The choice of the skin incisions used is optional. For a bilateral dissection the transverse incision might be used. The only objection to it is the necessity for undercutting the flaps to gain exposure which opens a raw area to possible infection. The type of material used for packing depends upon the conditions found. If no infected or extravasated material is encountered then

iodoform gauze is used. If, however, it is desired to evacuate infected material a rubber drain is inserted since it is less apt to act as an obturator than is gauze.

The life saving object for the operation is to block the paths of spread of infection to the mediastinum. This should be done first. During this procedure extravasated material may be encountered and drained. If it is not it is debatable whether or not the point of perforation should be searched for and a drain placed down to it. It is felt that this should be decided by the circumstances of each individual case. Search for and drainage to the perforation is probably unnecessary since the infection will tend to gravitate down to the region of dissection and from there will have a vent to the outside.

The only problem in the postoperative care is to furnish adequate food and fluids while keeping the œsophagus at rest. This may be done by inserting a small catheter into the stomach for feeding. Nourishment by hyperdermoclysis, vein, or rectum may be given. If the perforation is large, gastrostomy is probably the preferable method.

Due to the development of œsophagoscopy, patients with perforation of the œsophagus are seen by the endoscopist. It is his duty to decide whether perforation exists and when external operation is needed. The burden of management is his. But we have found that close co-operation between the endoscopist and surgeon leads to a mutual understanding and appreciation of the problems involved, with a consequent benefit to the patient.

Our rules for management of the various types of perforation of the cervical œsophagus have recently been presented (2). They will not be repeated here except to reiterate the contention that since many if not a majority of perforations occur in the cervical œsophagus and since death usually occurs from the dependent spread of infection to the mediastinum and since this spread may be prevented by an operation without undue risk, then all outspoken cases of perforation of the cervical œsophagus deserve early external operation; this, in order that the surgeon may do what nature has failed to do, namely to separate the fascial spaces of the neck from those of the chest.

SUMMARY

Perforations of the cervical œsophagus frequently result in a fatal spread of infection to the mediastinum. This may usually be prevented by early operation. The original procedure of Marschik for this purpose has been modified by a low cervical exposure obtained from mobilization of the thyroid gland and by blocking the fascial space behind the œsophagus.

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BENNETT'S FRACTURE AND OTHER FRACTURES OF THE FIRST METACARPAL[1]

R. W. McNEALY, M.D., F.A.C.S., AND MANUEL E. LICHTENSTEIN, M.D., CHICAGO

EDWARD HALLORAN BENNETT was professor of surgery at Trinity College, Dublin. He was born in Cork, April 9, 1837. His medical education was obtained at Trinity College from which he received the degree of M.B. in 1859. He was immediately appointed demonstrator of anatomy from which position he rose rapidly and in 1864 succeeded J. K. Barton as University anatomist. While in this capacity he made use of the wealth of material at his disposal and was able to collect sufficient specimens of bone injuries to speak with authority in this field of bone pathology. In 1863, he became a fellow in the Royal College of Surgeons, was soon made councillor and, in 1884, became president. He was one of the promoters of the union of medical societies in Dublin which resulted in the formation of the Royal Academy of Medicine of which, in 1897, he became president. His labors in general surgery were obscured by his special interest in bone disease.

To his fellow practitioners he was always a model of honor and uprightness. No one ever heard it said that Bennett did a crooked thing. He was blunt, sometimes emphatically so, but he always said what he believed to be the truth although that might not be pleasant to hear. He was a man of strong personality and in his criticisms of other men's work, he was very outspoken but never unfair. He never said an unkind word of anyone. He was thoroughly straightforward in all his ways and he detested anything underhanded. The result was as might be expected that no man had fewer enemies or more friends.

His manner toward the poor patients in the hospital was gentle to a degree, while his fondness for children was proverbial so that he was a great favorite with them. He was a man of retiring habits and his figure was rarely seen on public platforms or at great social gatherings.

He loved teaching the students in the hospital wards, were they the most junior or the most advanced, and nothing did he enjoy more than discussing with them some difficult case or propounding some points of diagnostic interest. His liveliest interest lay in the diagnosis and the pathology of rare fractures. He had a facility for awakening the interest of students and of attaching them to him as loyal and believing followers. If he sometimes appeared brusque in manner or in tone, his students knew he was at heart, generous, encouraging, a just and tolerant judge, a man devoted to their interests and always helpful in those things that led to their success.

He was the colleague of men who seem to have directly inherited and brought to their profession in a later day the manners of eighteenth century Dublin—a culture that went hand in hand with a kind and robust humanity. He maintained while availing himself of modern scientific resources, the attitude toward life of a generation who were never forgetful of the high import and dignity of their profession and who never allowed science to defeat its object or leave them too well equipped but too little capable. He was dignified without pedantry and cultured without arrogance.

When he lectured as university professor, he came to treat of surgery, having at his command the resources of literature and a great and nice knowledge of the Classics. His lectures were learned and academical, far removed from mere recitals of facts that under the name of science become impersonal and inorganic because they lack the teacher who can assimilate and subordinate them

Edward Halloran Bennett—1837–1907

[1] From the Department of Surgery, Northwestern University Medical School.

to their proper ends of humanity. One could see with what reverence he esteemed his calling, if only from the respect and enthusiasm with which he always spoke of the work of his colleagues or his predecessors. He would dwell on names well known in medicine with admiration and revive them with his own personality until the pupils on the benches shared his enthusiasm. He had a wider experience than the generality of men and a wider humanity. He knew life well and the more he learned of it, the more he adorned it. His insight did not sour him for his was a great sanity. He was kind and forbearing—intolerant only of pretense.

He died in Dublin, June 21, 1907, in his seventy-first year.

Before the advent of X-ray examinations, the diagnosis of bone injuries was based on a careful consideration of the nature and manner of the trauma, the symptoms noted by the patient, and the physical findings derived after patient and diligent examination. The establishment of a pathological entity or type of fracture was accomplished by the accumulation of specimens in the pathological museums of the medical schools and large hospitals. A correlation of the clinical findings with the illustrative pathological specimens served as a basis for the establishment of a clinical entity.

As an example of the foregoing, the fracture described by Bennett and since then known as Bennett's fracture may be cited. While the use of proper names has been grudgingly condoned in recent medical literature, no greater tribute to the painstaking efforts of the surgeons of the pre-roentgen era can be conferred than the retention of the name of this observer as an object lesson to present day students whose work has been greatly simplified by the use of roentgen-ray examinations. A perusal of the writings which called the attention of the profession to this lesion is worthy of our consideration.

In 1881, Bennett exhibited before the Dublin Pathological Society a series of united fractures of metacarpal bones, 9 in number, all from the right hand, of which 5 were fractures of the first metacarpal bone. Concerning these 5, he stated:

> In each of the five examples of fracture of the thumb allowing for shades of difference, such as must always exist, the type and character of the fracture is always the same—a form and type of fracture not hitherto described in these bones. The fracture passes obliquely (*a.b.* in the cut) (Fig. 1) through the base of the bone, detaching the greater part of the articular facette with that piece of the bone supporting it, which projects into the palm. In all these specimens, the dorsal surface of the bone is free from any implication in the fracture, and this fact, combined with the small amount of displacement which occurs, rendered the fracture one extremely liable to escape detection. . . .
>
> So trivial an injury does this appear to be and the specimens show so little deformity except in some the signs of arthritis consequent on it, I might fairly be asked what importance attaches to the correct diagnosis. All will admit that a correct diagnosis even in trivial injuries is desirable but in this case the diagnosis is essential to a correct prognosis and here lies the importance of the injury. Seeing the value of the movements of the thumb no injury of it is to be lightly regarded and this fracture, though it united readily by bone and with almost inappreciable deformity, renders the thumb for many months lame and useless. . .

Fig. 1. Original cut illustrating Bennett's fracture.

At the annual meeting of the British Medical Association held in Cardiff, July, 1885, in an address delivered at the opening of the section of Surgery, Bennett stated, after showing the importance of assembling specimens of fractures:

> The small size of the bones and the light value, clinically, which we surgeons have been apt to assign to simple fractures of the metacarpus, delayed my study of them, and so, perhaps, the result has been all the better; for, without some time spent in accumulating, a number sufficient to attract attention could not have been reached. Taking at last the group into closer study, I was struck by the fact that one particular fracture outnumbered all others. Now if we look to the series before us, a remarkable fact is disclosed. Amongst these fractures, there occur six examples of fracture of the base of the metacarpal of the right thumb, and no others of this bone. In each of these the injury is the same. . . . Most remarkable is the fact that in every case the accident has been on the right side of the body. Certainly this injury once we know of its existence becomes vastly more common than any other of the metacarpus. If left to itself it unites with such deformity as this case shows, a trivial deformity after all. Why then deem the matter worthy of the notice of this surgical section of the British Medical Association. Simply for this reason, that I have ample proof that a hand so injured remains under the best of treatment long disabled and without treatment for a greatly longer time. When we consider the value of the right thumb to anyone who lives by handicraft or industry to any, rich or poor, we should not let unnoticed and undiagnosed this common injury. . . .

In the *British Medical Journal* of July 3, 1886, Bennett published a résumé of his previous articles reported in 1882 and 1885. He stated:

> I now write this short note to make a correction in my account of the injury which, though of secondary im-

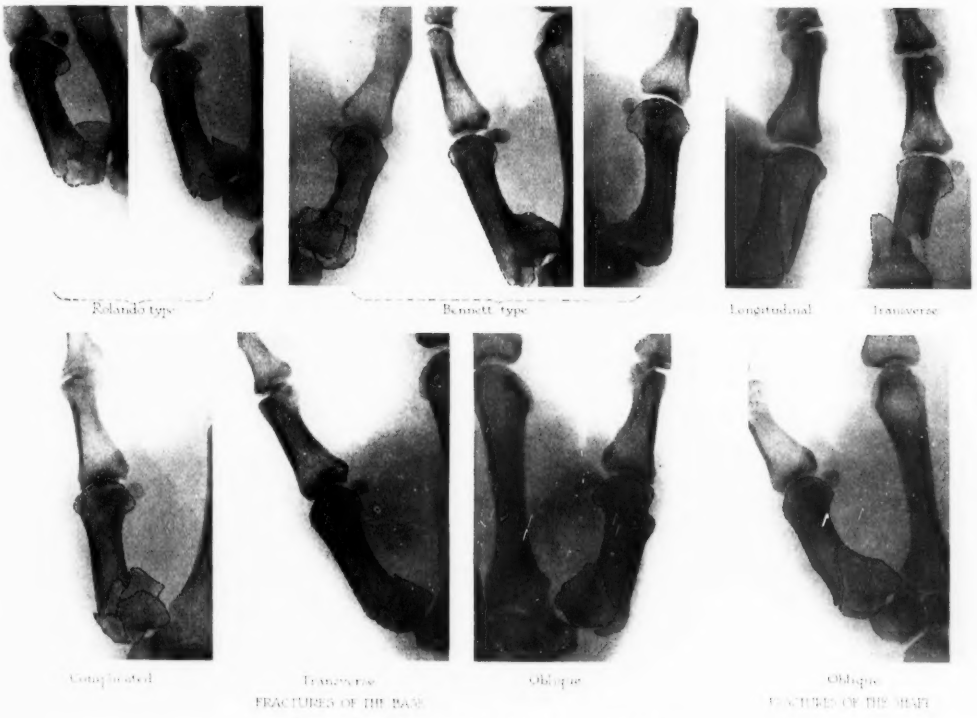

Fig. 2. Types of fracture of first metacarpal bone.

tance only, I prefer to make myself rather than have it made by another. I stated that every example I had seen in the living or dead occurred in the right thumb. I avoided committing myself to the assertion that it could not occur on the left side. I merely said "most remarkable is the fact that in every case the accident had been on the right side of the body." I am now able to supply a drawing taken from a left hand deformed by the fracture and to record the observation of two other examples on the left side in patients seen this session in Sir P. Dun's hospital. Thus I hope to correct whatever of error might have arisen from my record of my experience in August last.

The views expressed by Bennett concerning the importance of the thumb have not changed since his era. This is well exemplified by the fact that the State of Illinois Industrial Commission regards the value of the thumb as 60 weeks out of a total value for the entire hand of 185 weeks. Thus practically one-third of the value of the hand is vested in the thumb on the basis of utility in manual work.

Not all fractures of the first metacarpal correspond to Bennett's description. There has been considerable confusion of terms in descriptions of fractures of the first metacarpal and the classifications listed below summarize the various types of fractures of this bone (Fig. 2).

I. At the base.
  a. Intra-articular.
    1. Bennett type
    2. Rolando type
  b. Extra-articular.
    1. Transverse
    2. Oblique
    3. Complicated

II. The shaft.
    1. Transverse
    2. Oblique
    3. Longitudinal

III. The head.
    1. Transverse

Winterstein cites some interesting statistics on the relative distribution of fracture sites in 200 cases of fracture of the first metacarpal.

29 per cent Bennett type	Base 80 per cent of all
7 per cent Rolando type	
10 per cent extra-articular—oblique	
25 per cent extra-articular—transverse	
9 per cent complicated—several varieties	

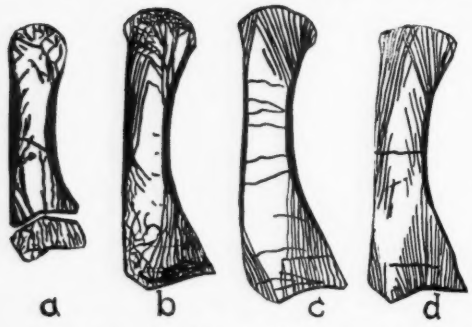

Fig. 3. Internal architecture of first metacarpal bone (after Magliulo).

1½ per cent oblique	Shaft
2 per cent transverse	Shaft
2 per cent longitudinal	Shaft
2½ per cent transverse	Head
5 per cent evulsion of capsule	Head

3½ per cent epiphyseal fracture—Bennett
2 per cent sesamoid bone fracture with head

These fractures were divided:

60 per cent in right hand; 97.5 per cent in men. It was found that direct trauma was usually of occupational origin while indirect trauma was due to falls, manipulations of thumb, etc.

ANATOMICAL DESCRIPTION

The first metacarpal bone presents a body, a distal extremity or head and a proximal extremity or base. The body has a radial and an ulnar border. The palmar surface gives attachment to the muscles of the thenar eminence while the dorsal surface is flat with a rounded extremity toward the base. The proximal articular surface is saddle shaped with a dorsopalmar concavity and a slight lateral convexity. The dorsopalmar concavity presents a dorsal portion which lies in a straight line with the body of the metacarpal and a palmar portion which projects outward from the body of the metacarpal at an angle.

Corresponding with this gross anatomical description is an internal architecture made up of layers of lamellæ which assume a definite shape and to a great extent determine the deformities produced when fracture occurs. Recent studies of Magliulo have clearly brought out the internal structure of the bone in the various age groups.

In adolescents (Fig. 3a) the diaphyseal cylinder is rather thin and little developed at the base. Two systems of lamellæ are seen: a posterior and an anterior of almost equal dimensions. Although these lamellæ are interrupted by the incomplete ossification, they retain the volodorsal direction in the posterior part. The lamellæ are very thin at the head of the metacarpus but an arched bundle passes from the volar part of the neck to the back.

In adults from 20 to 27 years (Fig. 3b), at the base the anterior system of lamellæ becomes triangular in form and is more robust than the posterior group, which is much smaller and made up of a few very thin lamellæ. The head preserves also the arrangement of the two systems of trabeculæ, that is the anterior and posterior systems.

In adults over 27 years (Fig. 3c), the compact tissue of the diaphyseal cylinder is generally thicker and the thickness is greater on the volar or concave than on the dorsal face where with advancing age, the compact tissue becomes thinner and finally changes to a thin dorsal layer (Fig. 3d). At the base, the anterior and posterior systems of lamellæ are preserved except that the posterior system is small and the start of rarefaction of the spongy tissue of the epiphysis is present. The compact tissue of the dorsal surface thins to only one lamina while in the volar surface it has a greater thickness. At the base, the anterior triangular system is present while the posterior system is lacking, having been replaced by areolar tissue. At the head only the anterior system is well developed.

From the foregoing it may be seen that the bony tissue of the diaphysis of the first metacarpus in the various ages is more developed in the anterior surface than in the posterior surface. At the base in all ages there is a system of trabeculæ in dorsovolar direction with lamellæ which are parallel to one another which form in their entirety a bundle, triangular in shape, the base of which occupies four-fifths of the articular surface and the apex of which lies on the concave surface of the metacarpus at the point of union of the diaphysis with the superior epiphysis.

MECHANISM OF FRACTURE

In describing the mechanism of fractures into the proximal joint, Rolando states that the dorsal articular process presents a much greater resistance to external violence than the palmar articular process, especially in injuries which act in the direction of the longitudinal axis of the metacarpal. The effect of this violence is to render the angle formed by the palmar articular process with the palmar surface of the metacarpal more acute. This results in an oblique fracture at the base of the process. The fracture then radiates from a point near the center of the articular surface to the

palmar surface. This is the mechanism by which Bennett's fracture is produced. The anterior triangular system of trabeculæ previously described are practically sheared off from the shaft of the bone. In this fracture the dorsal articular process and the body of the bone tend to become dislocated dorsally but this dislocation can only be incomplete if the ligaments uniting the trapezium with the metacarpus are intact. In those cases in which violence is very severe or long continued and is in the longitudinal axis of the metacarpus, it may lead to a fracture of the more resistant or dorsal articular process. In these cases there is a Y fracture in which the upper extremity of the first metacarpus is divided into three fragments, two of which correspond to the base and are dorsal and palmar, while the other corresponds to the shaft of the bone. This type is known as the fracture of Rolando. The articular fragment on the palmar surface constantly turns toward the thenar eminence. The dorsal articular fragment retains its relations with the trapezium. The lower fragment of the diaphysis may present a dorsal luxation as in Bennett's fracture or there may be no dislocation.

The two types of intra-articular fracture, that of Bennett and that of Rolando, correspond to fractures along the internal lamellæ of the base.

The mechanism of production of fractures of the first metacarpus has been investigated experimentally on the cadaver. Magliulo found that in 9 experiments where the thumb was abducted and slightly extended, a blow on the dorsum resulted in fractures of the Bennett type in 4; fracture of the trapezium in 1; laceration of the ligaments in 1; and no result in 3.

He concluded from his work that the mechanism of fracture depended upon: (1) the architecture of bone; (2) the age of patient; (3) the degree of extension and flexion; (4) the action of trauma.

The treatment of fractures of the first metacarpal is of importance because of the associated pathology which develops. Faulty union, atrophy of muscles of the thenar eminence, weakness of the grip, all contribute to the disability which may follow a simple fracture. In all of the extra-articular types, fixation in a position of extreme abduction will retain the web of the first metacarpal space and permit abduction when the splint is removed.

In the Rolando type of fracture, simple abduction is usually sufficient to produce approximation of the fragments of bone. The prognosis in this type of fracture is better than in the Bennett type because of the usual absence of upward dislocation of the shaft found in the latter.

In the Bennett type, the prognosis being not so favorable, special effort must be directed to overcome the pathological displacement. In addition to the extreme abduction suggested for the other type of fracture, longitudinal traction is essential if upward dislocation of the shaft has occurred. Many interesting procedures have been devised with this object in view.

Lambotte, in 1908, produced osteosynthesis by nailing together the fragments. Imbert and Cottalorda, in 1923, reported their procedure of osteosynthesis which did not differ radically from Lambotte's method. Baun used a nail driven through the distal fragment for the purpose of longitudinal traction.

Recently the incorporation of a wire loop in a plaster cast about the wrist has been utilized as a means of support for longitudinal traction produced by means of adhesive strips and rubber bands.

SUMMARY

Fractures of the base of the first metacarpal bone are most numerous, occurring in approximately 80 per cent of all fractures of the first metacarpal bone. Only one-fourth of these conform to the description of the Bennett type of fracture. This type of fracture is important because of the functional disability which follows when the fractured bone is allowed to heal without replacement of the fragments in correct apposition.

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ADENOMA OF THE AMPULLA OF VATER

FREDERICK CHRISTOPHER, B.S., M.D., F.A.C.S., EVANSTON, ILLINOIS
Associate Professor of Surgery, Northwestern University Medical School; Attending Surgeon, Evanston (Illinois) Hospital

BENIGN tumors involving the extrahepatic bile passages are extremely uncommon. A careful search of the literature discloses but 41 cases; the author adds 1 case. The authenticity of some of the earlier cases is somewhat open to question. Including the author's case, the relative frequency of the different types of tumors is: papilloma and polyp, 16; adenoma, 15; lipoma, 4; fibroma, 2; neuroma, 2; granuloma, 2; melanoma (classed as benign), 1; carcinoid, 1. Practically all the patients afflicted were of middle age or older. Most of them had an associated jaundice and other obstructive symptoms. In 6 cases the tumor seemed definitely to involve the ampulla of Vater. In some cases the tumors were successfully removed at operation and in a few the tumors were found by chance at autopsy. It is noticeable that the lesion has been given increasing recognition in the last 20 years.

In their discussion of this subject, Savy, Bonnet, and Martin[1] state that "epithelial tumors constitute the great majority of benign neoplasms of the biliary passages; they are represented by a hyperplasia of the glands, or the epithelial surface which becomes papillomatous. They are adenomata or papillomata . . . All benign tumors of the biliary passages, whatever their site, have two principal characteristics: they are associated with a previous state of inflammation, and they have a tendency toward transformation into cancer." According to Rolleston and McNee:[2] "the simple papilloma occasionally seen around the biliary papilla in the duodenum are growths of the intestinal surface of the papilla and not of the bile duct. Papilloma may, however, arise in the cavity of the ampulla of Vater."

The pre-operative diagnosis of benign tumor of the extrahepatic bile passages is probably never made. Carnot[3] says: "In the presence of jaundice which is at first intermittent and later continuous, operation is always to be recommended. The diagnosis lies between biliary calculus and tumor of the ampulla of Vater. If the gallbladder is large, it is more likely to be a tumor; if it is small and there is pain it is more likely to be a stone." When there are clinical signs of biliary obstruction and at operation the common duct is found to be dilated it will be necessary for the operator to satisfy himself as to the presence or absence of a benign tumor of the common duct or ampulla of Vater. Even if a calculus is found, a benign tumor may be present (see Rolleston's case). If the presence of a tumor of the orifice is suspected, it generally will be necessary to open the duodenum. Benign tumors may be removed by excision, curette or cautery and the prognosis may be excellent.

[1] Savy, P., Bonnet, P., and Martin, J. F., Lyon Chir., 1913, ix, 673.

[2] Rolleston, H. D., and McNee, J. W. Diseases of the Liver, Gallbladder and Bile Ducts. 3d ed., p. 740. London: Macmillan and Company, 1929.

[3] Carnot, P. Paris méd., 1928, May 19, p. 437.

The following cases of benign tumors of the extrahepatic bile passages have been found in the literature:

1. Lipoma, 1843, Bouisson. Inaugural Dissertation. Montpelier, page 137 (quoted by Konjetzny, G., Ergebn. d. allg. Path. u. path. Anat., 1910, xiv, 714.

2. Fibroma, 1862, Albers. Atlas der path. Anat., IV Boun plate 38 (quoted by Konjetzny) Abts page 490. Involved wall of choledochus causing obstruction with icterus (von Ehrmann's case).

3. Lipoma, 1869, Wardell. Lancet, Lond., 1869, ii, 407 (quoted by Konjetzny). At junction of common and cystic duct in a child of 3 years (Rolleston and McNee think that this tumor may have been a papilloma which underwent myxomatous degeneration).

4. Polyp, 1880, Pozzi, G. Gaz. med. ital-lombard (quoted by Konjetzny.) Jaundice of 87 days' duration disappeared with the passage of the polyp by rectum. Patient aged 40 years.

5. Polyp, 1884, Neusser. Ztschr. f. klin. Med., 1884, vii, 32; Neusser, E. (quoted by Bazin). Patient aged 39 years. Jaundice. Mucosal polyp, size of a pea, of common duct.

6. Papilloma, 1891, Jourdan. Bull. Soc. anat. de Par. (quoted by Konjetzny). Patient aged 48 years. Originated from cystic duct.

7. Papilloma (?), 1894, Chappet. Lyon méd., 1894, June 3.

8. Papilloma, 1894, Rolleston, H.D. Tr. Path. Soc. Lond., 1894, xlv, 83. In common duct near the site of a stone impaction.

9. Adenoma, 1895, Calzavara, C. Arch. f. path. anat., etc., Berl., cxli, 221 (quoted by Konjetzny). "Pure adenoma at orifice of common duct."

10. Myo-adenoma, 1895, Calzavara, C. Arch. f. path. anat., etc., Berl., cxli, 221 (quoted by Konjetzny). Involved common bile duct.

11. Polyp, 1898, Monari, A. Chir. méd. ital., xxvii, 5 (quoted by Konjetzny). 3.5 centimeters above the ampulla.

12. Papilloma, 1899, McPhedran. Sajous' Annual 1899, iv, 422 (quoted by Rolleston and McNee). Papillomatous growth around the duodenal orifice of the biliary papilla which gave rise to a suppurative cholangitis.

13. Lipoma, 1901 (?), Dickmann. J. de méd. prat. de Montpelier (quoted by Devic and Gallavardin Rev. de méd., 1901, xxi, 570. Common duct obliterated by lipomatous mass with icterus and large gall bladder.

14. Lipoma, 1901 (?), Ehrmann. Quoted by Devic and Gallavardin. Rev. de méd., 1901, xxi, 570.

15. Polyp, 1901, Krause. Inaugural Dissertation, Kiel (quoted by Konjetzny). Polyp projecting out of the ductus choledochus and accompanying a case of duodenal carcinoma.

16. Fibroma, 1901, Holzinger, J. Inaugural Dissertation, Munich (quoted by Konjetzny). Involved hepatic duct. Patient aged 75 years.

17. Granuloma, 1904, Mayo-Robson. Diseases of Gall Bladder and Bile Ducts, 3d ed., p. 200. (quoted by Savy, et al.). Benign tumor of cystic duct: inflammatory in origin.

18. Papilloma, 1906, Eve. Tr. Clin. Soc. Lond., 1906, xxxix, 144 (quoted by Rolleston and McNee). Arose from inside of common duct 1 inch above biliary papilla.

19. Adenofibroma, 1908, Volmer, A. Arch. f. klin. Chir., lxxxvi, 160 (quoted by Konjetzny). Involved common bile duct.

20. Papilloma, 1908, Tedenat, Cong. franç. de chir., 1908, abs., 5, p. 189 (quoted by Savy, et al.). Papilloma of choledochus almost obstructing canal.

21. Polyp, 1908, Pallasse. Soc. méd. d. hôp., de Lyon, 1908 (quoted by Savy, et al.). Involved common duct. Excision and recovery.

22. Melanoma, 1908, Duval, C. W. J. Exper. Med., x, 465, (quoted by Shapiro and Lifvendahl). "Melanoma of Vater's diverticulum and lower portion of the common bile duct causing complete obstruction."

23. Papilloma, 1910, Stein, J. Prag. med. Wchnschr., 1910, xxxv, 383. Patient aged 37 years. Papilloma obstructed ampulla of Vater. Hydrops cystis and icterus. Removed through duodenum by curette and cautery.

24. Adenoma, 1913 (?), Menetrier. Traité de Med., Brouardel-Gilbert, p. 176. Involved common duct.

25. Adenoma, 1913, Savy, P., Bonnet, Paud, Martin, J. F. Lyon Chir., 1913, ix, 673. Aged 67 years. Deep icterus. Involved common duct.

26. Adenoma, 1913, Savy, ibid.

27. Cystadenoma, 1913, Barberio, M. Policlin. Roma., 1913 sez. med., xx, 37. Associated with ascites and progressive icterus.

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31. Adenoma (?), 1922, Pickhardt. Klin. Wchnschr., Berl., 1922, page 1609. Patient aged 66 years. Icterus. Dilatation of bile ducts isolated tumor, pea sized, of common duct just before its entrance into the duodenum.

32. Adenoma, 1924, Leyro Diaz. Bol. y. trab. Soc. de cirurg. de Buenos Aires, 1924, viii, 250 (see also Bull. et mém. Soc. nat. de chir., lii, 1053, November 27, 1926). Adenoma at junction of cystic and hepatic ducts.

33. Papilloma, 1926, Sommer, Rene. Beitr. z. klin. Chir., 1926–1927, cxxxviii, 337. (Quoted by Bazin.) Benign papilloma of common duct.

34. Granuloma, 1928, Hammesfahr, C. Zentralbl. f. Chir., 1928, lv, 3157. (Quoted by Shapiro and Lifvendahl.) Foreign body granuloma developing around a nonabsorbable cat gut ligature used after cholecystectomy, and causing a stricture of the common duct.

35. Papilloma, 1929, Archibald, E. W. Discussion of Bazin's paper at American Surg. Ass'n., March, 1930. Ann. Surg., xcii, 662. Patient aged 60 years. Intermittent jaundice and nausea: pure benign papilloma involving half of common duct at its opening: successfully excised.

36. Papilloma, 1930, Bazin, A. T. Ann. Surg., xcii, 658. Benign papilloma of common duct, attached by narrow pedicle: removed surgically with portion of the duct.

37. Adenofibroma, 1931, Mayo, W. J. Quoted by Comfort and Walters. Ann. Surg., xciii, 1144. (See also Marshall, J. M. Proc. Staff Meet. Mayo Clinic, 1931, vi, 191.) Two cases of adenofibroma of the stump of the cystic duct which produced intermittent obstructive jaundice with symptoms of cholangitis.

38. Neuroma, 1931, Comfort, M. W., and Walters, W. Ann. Surg., xciii, 1142. (See also Walters, W., Priestley, J. B., and Gray, H. K. Surg. Clin. N. America, xi, 821.) Patient aged 55 years. Jaundice 2½ weeks. Neuroma 1.5x0.75 centimeters of middle portion of common duct. Successfully excised.

39. Papilloma, 1931, Marshall. Proc. Staff Meet. Mayo Clinic, 1931, vi, 191. Involved cystic duct.

40. Adenoma, 1931, Shapiro, P. F., and Lifvendahl, R. A. Ann. Surg., xciv, 61. Patient aged 69 years; had a ruptured gastric ulcer and died of bronchopneumonia. Adenoma attached to common hepatic duct. Caused no symptoms.

41. Neuroma, 1931, ibid. Patient aged 59 years. Amputation neuroma at stump of cystic duct.

In the following case there was an adenoma situated in the ampulla of Vater:

I. F. B., female, aged 74 years, entered the Evanston Hospital on February 5, 1932. There was a history of severe abdominal pain and vomiting of 12 hours' duration and a possible previous history of cholelithiasis. The pain was chiefly epigastric and somewhat more on the right. Two enemata were unsuccessful. There was marked rigidity of the upper half of the abdomen. The temperature was 97.5 degrees, the pulse 92, respirations 30, leucocyte count 20,750; the urine showed a faint trace of bile, a faint trace of albumin and rare red blood cells. Three hours after admission an exploratory laparotomy was done under ethylene anæsthesia with the most probable diagnosis perforation of the gall bladder or stomach. Through a right paramedian incision the transverse colon and stomach were found to be normal to inspection and palpation. There was no evidence of tumor mass in any part of the abdomen which was carefully palpated. The only region which presented any pathology was the under surface of the liver. In this region there were old dense adhesions which completely covered the gall bladder and obscured it from view. The duodenum was adherent in this region. The gall bladder was finally exposed by careful, tedious dissection of these adhesions. It was found to be about 2¼ inches in length and presented two constrictions in its proximal half. By following down the cystic duct an enormously dilated common duct was disclosed. This structure was at first thought to be duodenum but dissection and aspiration insured its identification. The gall bladder was opened, four small gall stones were removed, and drainage was instituted. The common duct was opened and a probe apparently passed into the duodenum over a roughened or somewhat obstructed part which seemed to be in the region of the ampulla of Vater. No stones were found in the common duct by the scoop. In view of the advanced age of the patient and her condition on the operating table, further exploration of the region of the ampulla of Vater was omitted. A T tube was sutured into the common duct and a single rubber tube was inserted in the gall bladder. A cigarette drain also was used.

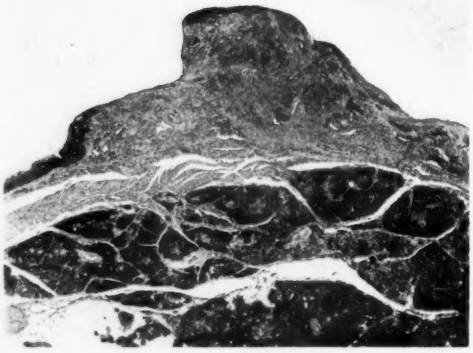

Fig. 1. Photomicrograph of adenoma of the ampulla of Vater. The darkly stained pancreatic tissue is seen in the lower half. The tumor is in the upper half projecting into the lumen of the common bile duct, a portion of the mucosa of which may be seen at the left.

The patient did very well after the operation except that the bile flowed externally instead of into the duodenum. Accordingly a second operation was done on February 24, 1932, 19 days after the first operation. At this operation a finger was easily inserted into the common bile duct and with gentle pressure seemed to pass through the sphincter at the ampulla and enter the duodenum. A rubber catheter with extra holes in it was now placed in the common duct so that 4 or 5 inches of it protruded into the duodenum distally from the ampulla. This was anchored to the skin by a silk suture. The common bile duct was closed around this suture and cigarette drain was placed. The patient went through this operation surprisingly well but bile continued to escape from the wound and none seemed to enter the bowel. Moreover duodenal contents escaped from the wound. After some 5 to 7 days, the wound broke down and was opened widely. A fæcal fistula, apparently originating from the colon appeared on the fourteenth day. The patient became rapidly weaker and died the eighteenth day after the second operation.

A postmortem examination was made by Dr. F. D. Gunn, pathologist, Evanston Hospital, who discovered an "enormously dilated common bile duct" the circumference of which was 6 centimeters, at the level of the fistula. The right hepatic duct had a maximum circumference of 2 centimeters. His report continues as follows:

"The gall bladder is shrunken down to the size of a small pecan. There is a 3 millimeter sized opening in its fundus which is partly surrounded by fibrous adhesions. The mucosa of the gall bladder is pink and about 2 millimeters in thickness. The lumen contains only a small amount of brownish mucus.

"At its lower extremity the wall of the common duct is thickened and indurated. One 5 millimeter sized granular, tumor-like nodule and several minute granules resembling granulation tissue project into and encroach upon the lumen. A 1 millimeter sized probe passes through the ampulla without forcing it. There is, also, a slit-like opening admitting the tip of the little finger which leads from the lowermost portion of the dilated segment of the common duct (about 1 centimeter from the ampulla) into the duodenum. At a distance of about 1 centimeter, distal to the ampulla, there is a lentil-sized nodule beneath the mucosa of the medial wall of the duodenum.

"*Microscopic findings.* Ampulla of Vater: The granular mass which was found projecting into the lumen of the common bile duct at the ampulla is composed of a mass of gland-like epithelial structures embedded in dense fibrous tissue and smooth muscle. They differ strikingly from the Brunner's glands, near which they lie, in that they are much simpler, more like embryonal structures and consist mainly of simple or branching tubules. A few of them show cystic dilatation, proliferation and desquamation of their columnar epithelium. No definite malignant changes are observed. The fibrous stroma is lightly infiltrated with lymphoid cells and eosinophils. The overlying duodenal mucosa shows postmortem digestion. A similar destruction of the lining of the ampulla is apparent.

"*Anatomical diagnosis.* Chronically inflamed adenoma of the ampulla of Vater with stenosis of the lumen of the common bile duct. High grade dilatation of the common bile duct and of the hepatic ducts. Chronic fibrous cholecystitis with contraction of the gall bladder. Recent surgical wound of the upper part of the abdominal wall (right rectus incision). Small surgical fistula between the fundus of the gall bladder and the floor of the abdominal wound. Surgical fistula of the common bile duct opening into the floor of the abdominal wound. Adenoma of the duodenal mucosa. Fatty infiltration of the pancreas. Brown atrophy of the heart. Hypostatic congestion and early lobular pneumonia of both lower pulmonary lobes. Small adenoma of the cortex of the left kidney."

SUMMARY

1. A case of adenoma of the ampulla of Vater is reported.

2. A survey of the literature of benign tumors of the extrahepatic biliary passages is presented.

ADDITIONAL REFERENCES

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CONGENITAL HYPERTROPHIC STENOSIS OF THE PYLORUS

A Study of Four Hundred and Twenty-Five Cases Treated by Pyloromyotomy[1]

THOMAS H. LANMAN, M.D., F.A.C.S., and PATRICK J. MAHONEY, M.D., Boston

TO justify surgical measures for the relief of any condition, certain facts must be established. First, and most important, can these surgical measures be made safe enough to justify the risk, not only of the operation itself, but of the incidental dangers attendant on any major surgical procedure? Second, are the end-results of such surgical measures satisfactory?

In this hospital the surgical treatment of congenital hypertrophic stenosis of the pylorus has for many years been regarded as the treatment of choice. This series of 425 cases covers the period from 1915 to 1931. In all cases, pyloromyotomy (Fredet-Rammstedt type) has been employed. Study of the results in this series establishes the safety of surgical treatment and also the fact that there is prompt and lasting relief of symptoms. The factors that we have found to be of importance in minimizing the mortality are emphasized.

MORTALITY

In Table I the total mortality in the series is shown to be 6.3 per cent. Of greater interest, however, is the reduction in mortality from 10.4 per cent in the first 125 cases, to 7 per cent in the next 150 cases, and in the last 150 cases, a further reduction to only 2 per cent. From the early part of 1930 up to the present time, June 1932, there have been no deaths.

The measures that have made possible this reduction in mortality have to do almost entirely with the differences between the surgical treatment of the small patient and the adult. In infancy or childhood all surgical procedures carry much higher proportionate risk, both operative and incidental. In congenital pyloric stenosis the technical difficulties of the operation itself are few, and in competent hands should be as slight as in any abdominal operation. Indeed, the apparent simplicity of this operation has been the source of considerable danger to these patients, for, as Barrington-Ward states in the preface to his *Abdominal Surgery of Children:* "The adult may be safely treated as a child, but the converse can lead to disaster."

The causes of death in this series are included in two main groups. In the first group are those incident to the technique of the operation itself, and include operative and postoperative hæmorrhage, wound infection, and peritonitis. In the second group are those causes due to the undernourished and dehydrated condition of the patient, which adds to the danger of postoperative shock and collapse, is a predisposing factor to infection, and leads to unsatisfactory healing of the wound. Such a condition also makes difficult the postoperative establishment and maintenance of the adequate nutritional and fluid needs of the patient.

In the operation itself, extreme care must be observed that all hæmorrhage in the abdominal wall incision be absolutely controlled. A right rectus muscle splitting incision, about 2 inches long with its midpoint at the edge of the liver, is used. The liver edge is the important landmark, not the costal margin. In making the incision in the pylorus, the "bloodless" area is selected. The upper and posterior surface of the pylorus is the point at which there is the least blood supply. The pylorus must be delivered into the wound, and its upper and posterior surface rotated outward and slightly downward to expose this area for incision.

Hæmorrhage from the pyloric incision is usually slight, and is easily controlled by hot saline packs. If not controlled by these means, the bleeding point must be sutured with fine silk on a non-cutting needle. A clamp or tie will usually cut through the rather hard and friable tissues. If suture does not control the bleeding, a piece of the rectus muscle should be sutured over the bleeding points. The greater incidence of hæmorrhage from the pyloric incision in patients over 6 weeks of age has been an interesting observation in this series and will be considered in greater detail in a later paragraph.

Peritonitis may result more often from an operative perforation of the duodenum than from

TABLE I.—SUMMARY OF CASES

Years	Serial number	Number of cases	Deaths	Mortality per cent
1915–1923	1–125	125	13	10.4
1923–1928	125–275	150	11	7.0
1928–1931	275–425	150	3	2.0

[1]From the Surgical and Medical Services of the Children's Hospital and Infant's Hospital, Boston, and the Departments of Surgery and Pediatrics, Harvard Medical School.

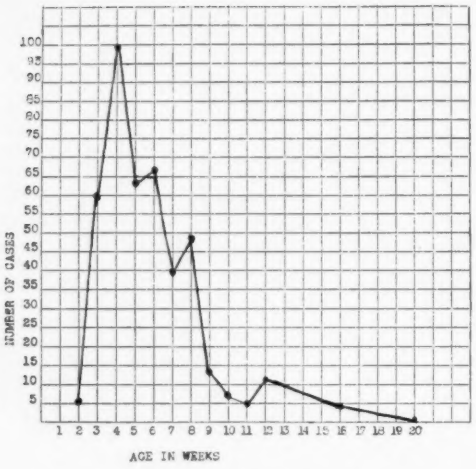


Chart. 1. Age at which hospitalization began.

a break in aseptic technique. The greatest care is necessary in making the incision at the duodenal end of the hypertrophied pylorus. It is here that the hypertrophied pylorus terminates abruptly at the duodenum which is extremely thin. Perforation of the duodenum is easy but avoidable. If perforated, the hole in the bowel wall should be closed at once with a silk stitch. In this series, the duodenum was perforated three times but in only one case was there a fatal peritonitis. Peritonitis may also be the result of operating near or through an infected field. In one case in this series there appeared to be a definite relation between an omphalitis and a later postoperative peritonitis. Peritonitis may also be a metastatic affair, the result of a bacteriæmia or septicæmia, secondary to other foci of infection, usually an upper respiratory infection. In 2 cases in this series, a peritonitis occurred in poorly nourished infants from 16 to 20 days after pyloromyotomy, despite the fact that vomiting had ceased. The peritonitis was undoubtedly a metastatic one.

The lowered resistance and resulting diminished power of healing in these patients requires the most rigid asepsis and hæmostasis, also the most meticulous care in approximating the abdominal incision layer by layer. Postoperative evisceration following delayed healing, due to imperfect approximation, low grade infection, hæmatoma, or combination of any or all of these factors may occur. In this series, in 3 cases, the incision reopened on the fifth to the seventh day. There were 2 deaths. Deaths due to operative peritonitis, hæmorrhage, evisceration are largely preventable and in our series accounted for 6, or 22 per cent of the total mortality. The remaining deaths were classified under such headings as malnutrition, "collapse," and acute nutritional disturbance. The causative factor in a large majority of these cases was the patient's undernourished and dehydrated condition, and the inadequate measures taken to combat it, both before, during, and after the operation. Important as is the proper operative technique the adequate pre-operative and postoperative care is even of greater importance in reducing the mortality rate. Seventy-eight per cent of our total deaths were due to causes other than faulty operative technique.

The steady decrease in our mortality rate has been concomitant with a longer pre-operative stay in the hospital. This longer pre-operative stay is not inclusive of the period of observation that certain cases received before diagnosis was established. The longer pre-operative period represents the time spent in overcoming the dehydration of these patients.

THE PRE-OPERATIVE CARE

Pre-operative care must be based on reason and not on any routine procedure. The operation is not an emergency. Where early diagnosis is made, much less in the way of pre-operative care is required. However, in the majority of these patients, vomiting has caused a loss in body fluids and has caused a loss in blood chlorides, which may result in alkylosis. The starvation incidental to prolonged vomiting has caused a depletion of the glycogen reserve in the body with its resulting ketosis.

Dehydration must be combated by salt solution given by hypodermoclysis. This supplies fluid for the depleted body tissues and aids in the restoration of electrolytes lost by persistent vomiting. Intravenous administration of glucose solution while not providing directly for the loss of body fluids, does account for the removal of ketone acids, and promotes re-establishment of renal function. At this hospital it is usual to give 10 per cent glucose solution intravenously, and normal saline by hypodermoclysis. In the extremely cachectic patients we give, in addition, a blood transfusion, 10 cubic centimeters per pound of body weight. Blood transfusion is now found advisable in only about 5 per cent of the patients treated. Twenty-four to forty-eight hours is time well spent in combating dehydration before operation.

Next in importance is the prevention of loss of body heat. Exposure contributes proportionately more to operative shock than in older patients. The field of operation exposed, though actually small, is proportionately a much greater surface area than in adults. The patient is placed on warm blankets beneath which some form of heat may be constantly applied. The legs, arms, and chest should be wrapped in flannel bandages.

POSTOPERATIVE CARE

After operation the infant should be immediately dried and redressed in warm coverings, and the body heat constantly maintained. The postoperative feedings by mouth cannot at first be sufficient to meet either the caloric or fluid needs, as the effects of dehydration may still be present. The following method has proved effective in our hands.

2 hours following operation, 1 ounce of sterile water.
2 hours later, 1 ounce of sterile water.
2 hours later, 1 ounce of whey. Repeat at 2 hourly intervals for 3 feedings.
2 hours later, ½ ounce of whey and ½ ounce of breast milk.
Repeat for 3 more feedings. Then decrease whey by 1 dram for each feeding and increase breast milk by 1 dram until whole breast milk is taken,—1 ounce.
Breast milk is then increased by dram amounts each 2 hours until such time as the patient is getting 1½ ounces each feeding. The next procedure is to lengthen the interval and increase the amount, and finally to change to a modified milk formula if the mother's milk is not available.
(A suitable breast milk substitute is used from the start if breast milk is not obtainable.)

This schedule of feeding by mouth does not meet either the caloric or fluid needs of the infant for the first few days. It is unwise in the usual case to attempt to meet them by feeding by mouth before the fifth day after operation. It is, therefore, necessary and most important, during this period, to supplement the oral intake of fluids by rectal taps, hypodermoclysis of salt solution, or the administration of intravenous glucose. The infant should receive and retain 3 ounces of fluid per pound of body weight each 24 hours, and the chloride and glucose requirements of the individual patient must be met. In this series, 5 of the 27 deaths were attributable to faulty operative technique. This number should, of course, be still further reduced until the irreducible minimum be reached beyond which the human element cannot go. In the private practice of the staff the mortality is negligible. In a hospital series, the poor risks are always present and their number will decrease only as a greater number of cases are recognized early and proper treatment instituted. But there is great need of recognizing that the poor operative risks can be brought into much better condition to withstand surgery than was formerly the case.

Our reduction in mortality from 10.2 per cent in 1915 to 1923, to 2 per cent in 1928 to 1931 was not entirely due to more skilled and experienced operators, but rather to better pre-operative and postoperative care. There was only one operative death in which the operator had had only small operative experience in these cases, death in this case being due to hæmorrhage from the pylorus.

ANÆSTHESIA

Ether given by the open drop method seems to us the anæsthetic of choice. Gas and oxygen; avertin, supplemented by gas and oxygen, or ether; all have their place. Novocain alone has not been used in this clinic for 4 or 5 years. It adds to the risk by prolonging the time of operation and may interfere with healing of the wound. Ether was used in 98 per cent of the patients in this series. In no instance did death occur on the table, nor was there any postoperative complication that could be directly traced to this anæsthetic.

Of the 27 deaths in this series, 9, or 33⅓ per cent, occurred in patients under 6 weeks of age. There were 294 cases, or 69 per cent of the series, in which operation was done before the patients were 6 weeks of age. This gives a mortality of 3 per cent in the younger group. Eighteen deaths, or 66.6 per cent of the total mortality, occurred in the group of patients who were over 6 weeks of age. This gives a mortality of 13.7 per cent for the 131 cases in the older group. In addition to carrying a much higher mortality, this group also includes a large number of cases in which hæmorrhage from the pyloric incision was greater in amount, and often required additional measures for its control.

In none of our cases was there any doubt as to the existence of a true hypertrophy of the pyloric fibers, but it was very noticeable that the older patients who had had a longer period of symptomatology did present a more vascular pyloric ring. A higher mortality in the older age group has been noted by other writers. It is our belief that the greater vascularity of the pyloric ring may be due to a superimposed element of pylorospasm which, although present to some degree in all cases, is increased as a result of prolonged symptomatology. When true hypertrophy of the pyloric ring is present, medical measures will

not effect as safe and as prompt a cure as pyloromyotomy. The greater morbidity and mortality in this older group plus the fact that all of them had a true hypertrophic stenosis convinces us that early surgical treatment should be instituted, that it will carry less danger to the patient, and result in quicker relief of symptoms.

RELIEF OF SYMPTOMS

In practically all cases relief of symptoms has been prompt and lasting. We have been able to observe a sufficient number of cases over periods of 4 to 12 years to feel sure of this fact. In 2 cases a secondary operation was done because of persistence of symptoms. One of these had been operated upon previously at another hospital. The findings at this second operation revealed that the section of the constricting fibers was not complete. Re-incision throughout the entire length of the pylorus resulted in cure. In the other case there was apparently an incomplete division of the pyloric fibers. Symptoms had persisted and secondary operation 6 weeks later was unsuccessful, the patient dying 4 days after operation following evisceration. We have been able to observe the pyloric ring in cases in which death from other causes occurred 2 months to 7 years after pyloromyotomy. In all cases an apparently normal pylorus was present.

SIGNS AND SYMPTOMS

Chart I shows the age at which hospitalization began. Sixty-nine per cent were 6 weeks or younger with the peak at 4 weeks. The proportion of males to females was 84.7 per cent to 15.3 per cent

The five major signs and symptoms were:

1. Failure to gain, in the absence of fever, or other signs of infection.
2. Persistent vomiting of the projectile type, occurring shortly after feeding, the vomitus consisting of stomach contents, never bile stained.
3. Visible gastric peristalsis moving from left to right.
4. Scanty stools.
5. A palpable pyloric tumor.

Other signs and symptoms observed in many cases, and which confirm, rather than establish the diagnosis, are: (a) loss of fatty tissue, (b) dehydration, (c) ketosis (acetone breath and acetone in urine), (d) alkalosis (tendency toward hypertonicity and gastric tetany), (e) fullness of epigastrium (due to hypertrophy of stomach musculature and dilatation of the stomach), (f) flatness of hypogastrium (due to failure of food to pass through the pylorus), (g) diarrhœa. In 13 per cent of the case histories, diarrhœa was emphasized to a greater extent than scanty stools (frequently inaccurately referred to as constipation). The reason for the diarrhœa was usually obtained from careful study of the case history. Multiple forms of cathartics and enemas had been given to cure the patient of "constipation." In addition there may be the diarrhœa associated with starvation, the stools being composed of intestinal secretions.

The five major signs and symptoms have been observed prior to operation in all of the last 200 patients treated at the Children's Hospital. In only 1 case was the diagnosis not confirmed at operation.

The information from the barium meal roentgenogram shows the amount of food that passes through the pylorus and the rapidity of emptying of the stomach. It is possible to obtain this information, though not so promptly, by a study of the amount of fæces passed by rectum. The presence of barium in the stomach at the time of operation adds to the technical difficulties of operation. We now place less reliance on the shape of the stomach as shown by the roentgenogram in making a diagnosis than formerly. In the last 200 patients, the roentgenogram has been used in only 16 cases.

ETIOLOGY

We have no satisfactory theory as to the etiology of congenital hypertrophic stenosis of the pylorus. We found no evidence supporting the theory that injury to the central nervous system during birth, may be an etiological factor. We found no suggestive association between this disease and such conditions as megalo-ureter, or Hirschsprung's disease. There is no racial predisposition to this disease. Vitamine deficiency in the diet is apparently not a causative factor in this disease. We found no proof for the theory that the condition occurs more often in the first born. The occurrence of these symptoms in the first born is not, in itself, of especial diagnostic significance.

SUMMARY

Analysis of the 425 cases establishes the safety of surgical treatment of pyloric stenosis. Because the mortality and morbidity is greater in the age group of 6 weeks and over, who have had longer duration of symptoms and treatment, we advise operation as soon as the diagnosis is established. The shorter the period of symptomatology, the better is the operative risk. The safety of surgical treatment of pyloric stenosis is dependent on the close observance of many details. This includes:

1. Combating and overcoming the loss of body fluids before and after operation. The measures to be used are dependent on the degree of dehydration; the degree of dehydration will be greater in cases having a longer duration of symptoms.

2. Especial care in preventing loss of body heat before, during, and after operation.

3. The greatest care in controlling hæmorrhage at operation. Rigid asepsis and painstaking approximation of the abdominal wound.

4. Incision in the "bloodless" area of the pylorus, being sure that all constricting fibers are divided, but using especial care not to perforate the mucosa of the pylorus at the duodenal end. It is safer to use blunt dissection in completing the division and spreading of the serous and muscular coats.

5. Hæmorrhage from the pyloric incision not controlled by hot saline packs, must be controlled by suture with or without using a piece of rectus muscle.

6. The care during the first 4 or 5 days following operation must include the maintenance of the fluid requirements by methods supplementary to what can be administered by mouth. The caloric needs usually cannot be met for these first 4 or 5 days following operation and it is unwise to attempt to do so. If the fluid requirements, 3 ounces per pound of body weight, are met, the caloric intake is of minor importance during this short period.

7. We believe that ether by open drop method is the best and safest anæsthetic.

CONCLUSION

We believe that pyloromyotomy is the treatment of choice in congenital hypertrophic stenosis of the pylorus. This surgical treatment can and should be made safe enough to warrant its use in all cases. We believe that pyloromyotomy should be advised when the diagnosis is established and that it offers safe, sure, prompt, and lasting relief of symptoms.

EARLY DIAGNOSIS OF CARCINOMA OF THE CERVIX

DR. WALTER SCHILLER, VIENNA, AUSTRIA
II Gynecological Clinic, University of Vienna

AT present there are only two valuable methods of treating carcinoma: by operation and by radiation therapy. All attempts at serological, pharmacological, or dietetic treatment have so far proved to be of no practical value and have resulted in failures. It is rather doubtful, therefore, whether with present facilities of investigation, better results can be expected in the near future.

Of the two practical and valuable methods, the surgical treatment, at least as far as the gynecology is concerned, seems to have reached a point where no further improvement can be expected. Any changes in operative technique made in the last few years are simply modifications of well known methods. The technique of applying radiation in carcinoma of the uterus seems almost to have reached a similar stage. It is true that in the last few years some modifications have been made but it would seem that progress can be expected only from the physicists through the invention or discovery of new tubes and rays, for the radiologist now makes the best possible use of the instruments which have been given to him by the physicist.

Early diagnosis and treatment are the only and the best means we have today of improving the results in the treatment of carcinoma. There is no doubt that early operation and the application of radiological measures before the wide extension of the cancer decidedly improves the prognosis. If the carcinoma is internal and therefore cannot be seen, early diagnosis is difficult and probably depends upon some general reaction yet to be discovered, the presence of which may be revealed by examination of the blood, urine, serum, or skin. Of course, if diagnosis were thus possible it would still be very difficult to find the site of the tumor. At the present moment, in spite of the high standard attained in the study of cancer we are far from reaching this goal. Somewhat more favorable are the possibilities of detecting carcinoma of the epithelium in areas readily examined with the eye, as for instance the skin, mouth, penis, vagina, cervix. In any case the main thing is to be able to make diagnosis during the earliest stage; this can be done only if patient comes for consultation during this stage.

The laboratory of our clinic, following the example of Wertheim Schottlaender and Kermauner, is making a most intensive study of carcinoma of the cervix and for some years we have been making extensive examinations in an effort to make a diagnosis in the early stage of carcinoma of the cervix. The first condition necessary in making such a diagnosis is to obtain data as to the appearance peculiar to the growth in the earliest stages. My first work, therefore, was devoted to discovering this information. The work was simplified by the fact that the area of predilection for carcinoma of the cervix is the region near the external os. Thus I was very likely to find data in a systematic examination of some 100 or 1000 uteri. As a matter of routine I have for several years examined under a microscope cross sections of the cervix of each uterus removed at our clinic for any reason, for example, fibroids, inflammatory tumors of the adnexa, inflammation of tubes, neoplasm of ovaries, etc. I have thus succeeded in securing data as to the histological pictures presented in the early stages of the carcinoma of cervix. It must be clearly understood that these histological findings, which I can describe morphologically quite precisely, really represent the earliest stages of a carcinoma which, if not removed, would have developed into the more advanced type of carcinoma of cervix. This would be easy to prove, if the early cancer were a miniature of a developed carcinoma, just as a young mouse 3 weeks old is a miniature of an old one, consideration, of course, being given to the difference in size. The scientist as well as a person not familiar with science who has no knowledge about mice would conclude from morphological similarity that the grown up mouse develops from the young one. The evidence is more difficult if the early stages are morphologically different from the final stage. There is no morphological similarity between a 10 day old embryo of a mouse and a newborn mouse and the common sense upon which many biologists think they can rely is missing. Direct observation is not readily possible either, as we cannot observe the embryo's development into a mouse. The evidence that the embryo is the first link in the development of a newborn mouse can only be secured through a series of microscopic pictures to include the whole evolution with the intermediate stages. These changes are not accessible under direct observation, but it is possible to

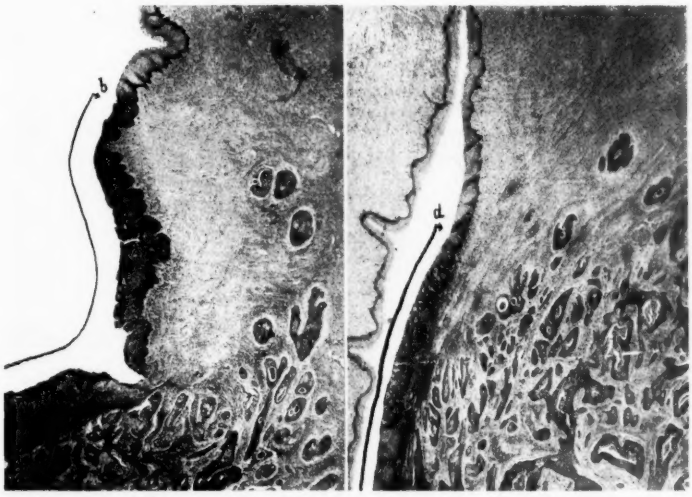


Fig. 1A. Fig. 1C.

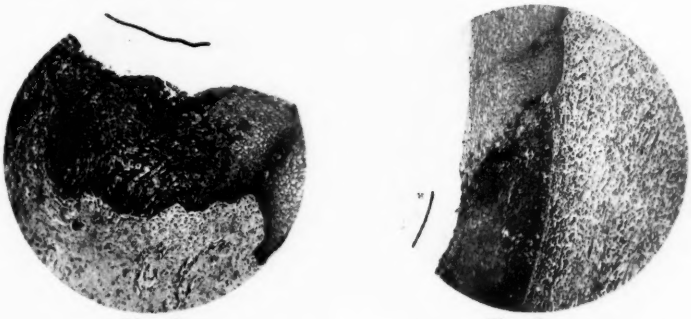


Fig. 1B. Fig. 1D.

Fig. 1. Case No. 20237. A, Advanced solid carcinoma of the squamous epithelium of the cervix with an extended border layer. At the upper border of the section the carcinomatous border passes sharply into normal epithelium. The thin line here and in the following illustrations marks the superficial extension of carcinoma. (×20.) B, Transition of carcinoma and normal epithelium highly magnified. (×50.) C, Another marginal portion of the same carcinoma with characteristic sharp and sloping transition. (×15.) D, The same transition highly magnified. In the characteristic way the carcinoma appears further in the deep layers and the normal epithelium in the superficial layers. (×50.)

secure a complete series of slides showing intrauterine development. This method, the foundation of embryological research can be applied as well to the development of carcinoma. The prevailing opinion as to carcinoma is based upon a study of carcinoma in the advanced stage at which time it has become superficially ulcerated and penetrates deep into the organs, and this picture has remained with us since before microscopic research was known. The microscope, however, revealed further characteristics, namely atypism and polymorphism, in short the irregularity of cells. I am going to attempt to show that in the earliest stages of carcinoma the microscopic features mentioned are found instead of the older macroscopic characteristics.

For didactic reasons I shall not begin with the smallest carcinoma but with the type of carcinoma which has been diagnosed clinically for many years and has been accepted as such; in other

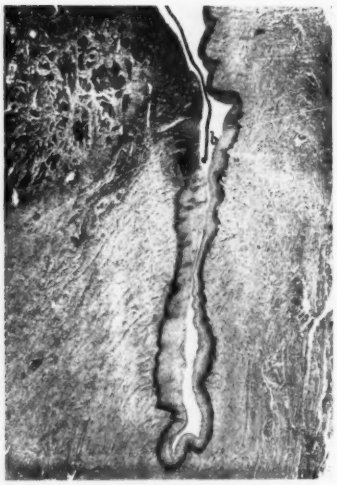


Fig. 2A.

Fig. 2. Case No. 18610. A, Advanced solid carcinoma of the cervix, marginal part. Normal epithelium to both sides of the fornix. Between the carcinoma and the normal epithelium there is a small and short carcinomatous layer which is smaller than the normal epithelium and from which it is sharply separated. It forms characteristic blunt mushroom-like projections which do not grow deeply. (×18.) B, The short carcinomatous border layer with round epithelium projections and the sharp transition in comparison to the normal epithelium highly magnified. (×37.) C, Carcinomatous epithelium from the border layer. (×475.) D, Carcinomatous epithelium from the downgrowth of a deeply penetrated carcinoma. The histological picture shows the absolute similarity to the carcinomatous layer in B. (×475.)

words, the carcinoma upon which our ideas of this growth have been founded. An examination of the region immediately surrounding a large carcinoma of the cervix reveals that in most of the cases the growth is separated from the normal epithelium by a small inflammatory zone free of epithelium. Wherever the carcinoma penetrates from the surface into normal tissue there is present a narrow zone with inflammatory infiltrated connective tissue not covered with epithelium or with cancer. Although in a small percentage of cases the carcinoma is in direct junction with the surrounding normal epithelium (so that the normal epithelium does not project over the downgrowth) the carcinoma forms a surrounding superficial layer of about the same depth as the normal epithelium and, as I have always found, definitely marked off, as though the area had been outlined with a ruler. Schottlaender and Kermauner were the first to notice the superficial narrow layer. They called it the carcinomatous superficial layer. While they mention only a few cases, in my systematic examinations I have found a great number of cases presenting these carcinomatous layers. When examining carefully I have also found that when in one spot carcinoma is marked off from normal tissue by a zone free of epithelium the growth is usually wholly surrounded by such a zone free of epithelium, and if there is a carcinomatous layer in one place the growth is always completely surrounded by such a carcinomatous layer. Obviously the kind of demarcation does not depend on local circumstances but rather on the biological nature of the carcinoma and of the organism in which carcinoma develops.

The question arises: Is this carcinomatous layer really a part of the carcinoma? On the basis of the characteristics of advanced carcinoma the answer must be in the negative, for the carcinomatous layer is neither superficially ulcerated nor does it invade the deeper tissue. Neither does it meet a further requirement: the layer is definitely marked off from the connective tissue and does not show any tendency to penetrate deeply neither by single cells nor by groups of cells. From the old and antiquated point of

Fig. 2B.

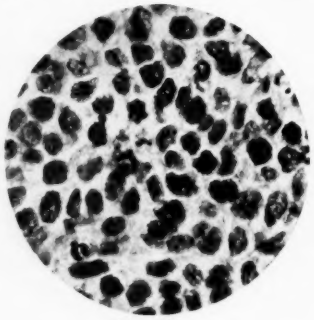
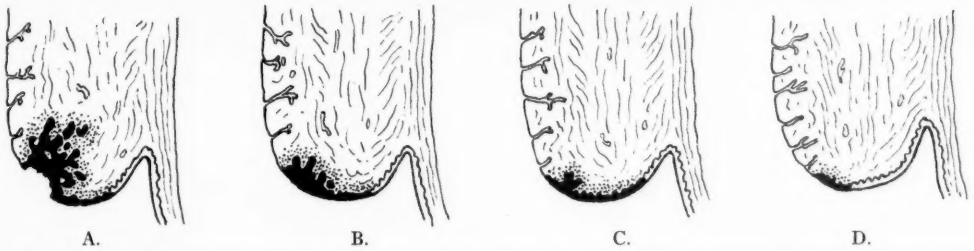


Fig. 2C.

Fig. 2D.



A. B. C. D.

Fig. 3. Diagram of the development of a carcinoma of the squamous epithelium of the cervix. A, Advanced downgrowth, superficial ulceration, carcinomatous superficial layer. B, Downgrowth and superficial layer. C, Beginning downgrowth and superficial layer. D, Superficial layer only, which means change of superficial squamous epithelium next the external os into the carcinomatous type. The carcinoma begins to develop as shown in D and progresses as shown in C, B and A.

view, carcinoma is diagnosed only when it penetrates deeply and then the carcinomatous layer is separated from the carcinoma and is considered a surrounding region, not a carcinomatous zone. From the histological point of view, however, this hypothesis is altogether wrong, because the layer shows the characteristics of carcinoma—atypical and polymorphous cells and frequently plenty of mitotic figures. In addition there is no histological difference whatsoever in the area where the carcinomatous zone passes into the deeply penetrating carcinoma while there is a distinct histological difference at the point where the carcinomatous layer is marked off from the epithelium. We must of necessity therefore consider the carcinomatous layer as part of the carcinoma (Figs. 1, 2). In my systematic examinations I have found carcinomata in which the proportions of the downgrowth and the superficial carcinomatous layer were in inverse relationship to the usual proportion in advanced carcinomata in which the downgrowth is the paramount part while the carcinomatous layer is but a small area surrounding it. The amount of downgrowth is several hundred times as great as the superficial layers; in some of the smaller carcinomata however, the proportion is reversed. The carcinomatous layer is larger and, in the slide, frequently covers half the cervix, occasionally extending to the fornix while the deeply penetrating parts consist of but a few, relatively small downgrowths showing only very shallow superficial ulceration. In the next type we find a somewhat smaller carcinomatous layer with only 2 or 3 downgrowths at the external os, yet with no ulceration. In still a younger type there is but one small short downgrowth and no superficial ulceration. In the last and youngest type are the cases which have only a carcinomatous layer and no deep penetration, downgrowth at the external os, or ulceration.

The cases presenting the very small carcinomatous layer with no deep penetration or ulceration formed part of the material for my histological examinations. A study was made of cases presenting all of the intermediate stages from the beginning penetration at the external os, the progressing downgrowth with ulceration at the external os, up to and including the large advanced carcinomata which completely infiltrate the collum and are superficially ulcerating crateriform growths (Fig. 3). If the carcinomatous area bordering the carcinoma is recognized as carcinoma, and we are logically bound to accept this assumption as true, then from our study of the uninterrupted series the smallest carcinomatous layers with no downgrowth must be considered as carcinoma as well. That is a picture of the youngest stage of carcinoma that we are able to recognize at the present moment. These smallest of carcinomata which include the last cases in our histological collection are 2 to 3 millimeters in diameter, sections of epithelium at the external os, the epithelium, through changes in its cells to polymorphic and atypical types, becoming characteristic of the carcinomatous layer.

In this early type there is no downgrowth or metastasis—two phases in the development of carcinoma. Downgrowth is bound to develop; sometimes it appears early, but sometimes it may not appear for months and years. The same is true as to the early and late appearance of metastases. It must be emphasized, however, that the presence of carcinoma is not synonymous with downgrowth—there is an early stage of carcinoma in which are present certain tissue changes characteristic of this stage of development, for instance the cell changes, the appearance of atypical and polymorphic cells—but the growth has not begun to penetrate the deeper tissue.

Fig. 4A.

Fig. 4. Case No. 25628. A, Commencing carcinoma of squamous epithelium at the external os not penetrating deeply yet. The carcinoma appeared over the region of a healed cystic erosion. (×15.) B, Carcinomatous tissue from the layer highly magnified. (×475.)

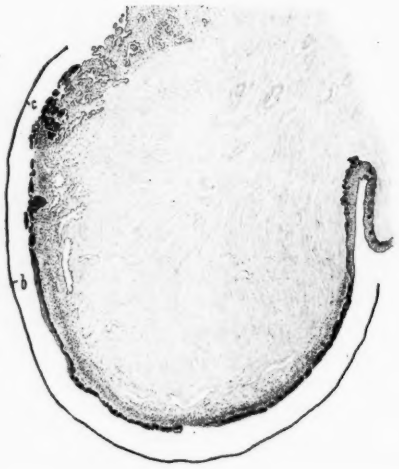


Fig. 5A.

Fig. 5. Case No. 17296. A, Commencing carcinoma consisting of an extended superficial layer which has penetrated deeply in one place only. The deepest part lies 1½ millimeters from the surface. (×5.) B, Carcinomatous layer highly magnified. (×67.) C, The region of deep penetration highly magnified. (×50.)

The objection that the carcinomatous layer is not carcinoma because it does not penetrate deeply is equivalent to saying that the embryo of a mouse has not the characteristic features of a mouse because the embryo does not breathe through its lungs as a grownup mouse does. Breathing through the lungs is a postnatal characteristic of the mouse while the properties of a mouse are inherent in the embryo.

The term "precancerous" for carcinomatous layers seems to carry two different meanings: some authors use the term "precancerous" to designate a growth which may become a carcinoma while others use the term in reference to a growth which is bound to become carcinoma. As long as the term "precancerous" has more than one meaning it should be avoided. The study of our uninterrupted series would indicate that a carcinomatous layer may represent two things: either the borderline of an advanced carcinoma—in which case it is senseless to call it anything else but cancerous—or the early stage of carcinoma which later on will penetrate deeply. In this case too it is better to use the term of "young carcinoma" or "early stage of carcinoma," instead of the ambiguous term "precancerous." Our experience has demonstrated that the smallest carcinomatous layer without downgrowth will later, if allowed to grow, develop into a deeply penetrating carcinoma and eventually ulcerate superficially. We do not speak of a "prehuman" embryo but of a "human" embryo and I believe the same thing applies to cancer; there is a "carcinomatous" layer but not a "precancerous" layer.

Fig. 4B.

Fig. 5B.

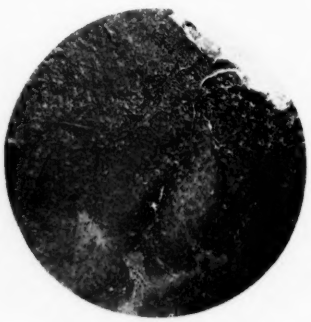


Fig. 5C.

Fig. 6A.

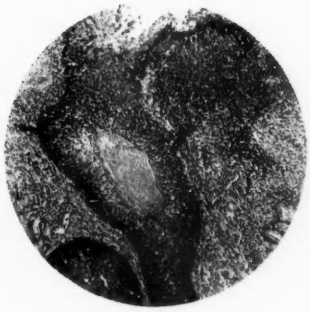


Fig. 6B.

Fig. 6C.

Fig. 6. Case No. 19704. A, Early commencing carcinoma of the cervix consisting of a larger superficial layer and two small projections in the region of the external os. The section shows the characteristic carcinomatous superficial layer and its separation from the normal epithelium to the right. (×20.) B, Two small projections dip deeply into the region of the external os with strong inflammatory infiltration of the surrounding tissue. (×40.) C, Tissue from the carcinomatous layer highly magnified. Atypical mitotic figures, atypical nuclei. (×475.)

The histological characteristic of this carcinomatous layer has already been mentioned: polymorphic and atypical cells, especially as regards the nuclei. Large nuclei may be surrounded by small ones, dark nuclei may be next to light nuclei, and occasionally giant cells may be found with several nuclei in one cell. The great number of nuclei is extraordinary, there being more nuclei than in the healthy epithelium. The regular order, as seen in normal epithelium, is absent. In healthy epithelium the number of nuclei diminishes centrifugally from basal layer to the surface, until in the superficial layers only a few, shrunken nuclei lying in large cell alveoli, are found. In the presence of a carcinomatous layer, however, we find on the surface a great number of dark nuclei lying close to one another. The basal layer is sharply demarcated against the underlying connective tissue and never shows projecting single cells or groups of cells. This is no counterevidence against the carcinomatous character of the epithelium. In advanced carcinomata of great maturity the projections in the depth of tissue with sharply defined basal cell layer are regularly seen (Fig. 7). The division and separation into basal layer, prickle-cell layer, superficial vesicular, parakeratotic layer are abolished. Occasionally, however, we can still find remnants of the former epithelial differentiation in carcinomatous epithelium. Just as there are hornifying carcinomata of the skin, and the ability of the normal skin to become horny is still preserved, and just as there are carcinomata of the mucous membrane and the function of the normal gland is preserved (the pathologist calls them carcinomata of very advanced maturity or of great dif-

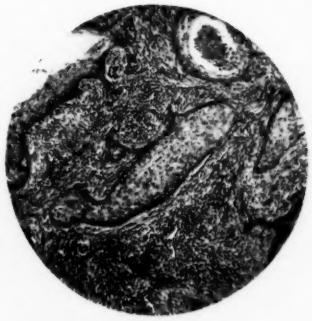


Fig. 7A.

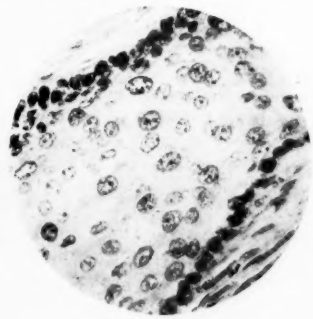


Fig. 7B.

Fig. 7. Case No. 27790. A, Projection from a hornified carcinoma of the cervix of high maturity. (×40.) B, A projection in high magnification with distinctly demarcated basal layer. (×240.)

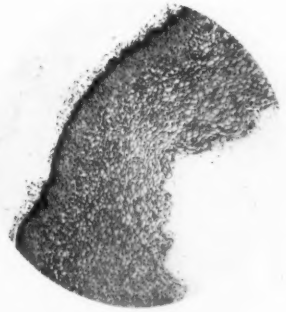


Fig. 8.

Fig. 8. Case No. 27484. Normal vacuolized epithelium containing glycogen, from a scraping. (×57.)

Fig. 9A.

Fig. 9. Case No. 27027. A, Commencing carcinoma of the squamous epithelium of the cervix which led to an inoperable reappearance in spite of a hysterectomy. The carcinoma consists of a small superficial layer with only little downgrowth along the cervical glands in the cervical canal. In spite of an operation the tumor reappeared and was inoperable. (×5.) B, Transition in respect to normal epithelium, highly magnified. (×57.) C, The carcinomatous layer highly magnified. (×15.) D, Beginning of the deep penetration along the cervical glands, highly magnified. (×60.)

ferentiation), there are also carcinomatous layers still showing a distinct basal or parakeratotic layers on the surface, certain rests of differentiation. Such remnants of potency of differentiation do not contra-indicate the carcinomatous nature of the layer. The demarcation between the carcinomatous layer and the normal epithelium is always distinct, so that it is possible to indicate the exact point to which the carcinoma reaches and where the normal tissue commences. Areas of transition are nowhere to be found, nor are there transitory cells; in contradiction to this fact are the hornifying carcinomata of the vulva and of the skin in which there is no distinct demarcation between carcinomatous and normal tissue, obviously on account of the great maturity of tissue. Occasionally we can see within the normal tissue near the borderline single dark cells which, from a morphological standpoint, are characteristic of carcinomata. The line of demarcation is always oblique and always proceeds so that, in the basal part of the growth, it reaches farther than the normal epithelium does on the surface, i.e., the carcinomatous layer is wider at the base than on the surface. A further characteristic of carcinomatous epithelium is that the superficial layer, which in normal epithelium consists of large vesicular light cells with small shrunken nuclei or rests of nuclei, is missing. This superficial layer, which is typical in the epithelium of the cervix—normally the epithelium of the cervix does not show parakeratosis—is filled with glycogen as proved by staining (Fig. 8). As Schaffer pointed out the squamous epithelium undergoing differentiation may be transformed into horn or it may gather glycogen. In the epithelium of the cervix the latter property is characteristic, and the glycogen disappears when the epithelium becomes a carcinomatous layer. This is true not only for the superficial layer of the epithelium of the cervix; downgrowths and extension of epithelium too are free of glycogen. This glycogen is not soluble in water. It is called glycogen of the epithelium and should not be mistaken for the glycogen of the liver and muscles which glycogen is soluble in water. The insoluble glycogen of the epithelium can be stained according to Best on slides, which have been washed in running water for hours. Occasionally, soluble glycogen is found in carcinomata of the collum characterized histologically by large light vesicular cells. Lahm, Babes and Lazarescu-Pantzu have described such cases, which are rare and in which the glycogen is very different from the cervical epithelial glycogen.

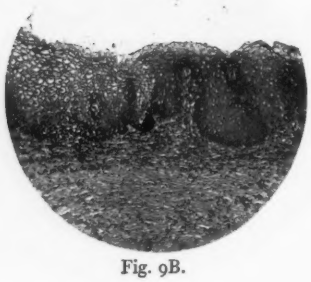


Fig. 9B.

Fig. 9C.

Fig. 9D.

Fig. 10A. Fig. 10B.

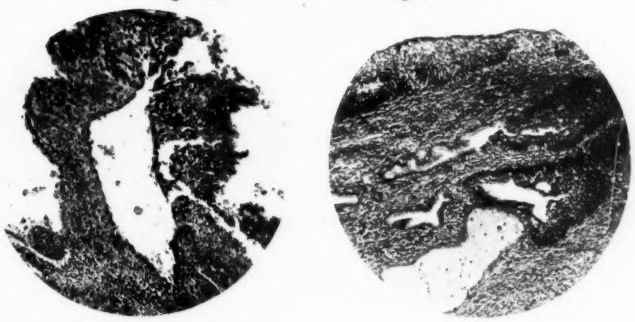


Fig. 10C. Fig. 10D.

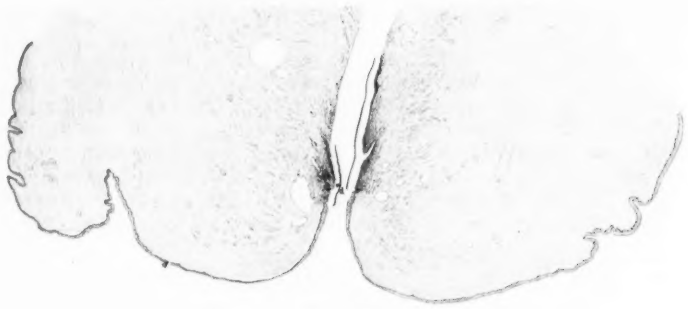


Fig. 10E.

Fig. 10. Case No. 27573. A, Cervix as it is seen through a speculum. B, After painting with Lugol's solution: The normal epithelium was stained a dark mahogany brown color, around the erosion an unstained uneven zone was seen which after hysterectomy and histological examination proved to be carcinoma. C, Scraping showed: Carcinomatous polymorphic epithelium. (×57.) D, Beginning downgrowth inside of cervical canal. (×60.) E, Section through the cervix: In consequence of shrinkage caused by fixation in formalin the carcinoma appears retracted in the cervical canal. (×0.8.)

A further evidence that the carcinomatous layers are actually carcinomata is to be seen in similar diagnoses in the skin. To Bowen belongs the credit of discovering and describing such findings in relation to the skin. He was the first to notice the changes in the epithelium which are characterized by polymorphic and atypical cells, great numbers of cells and nuclei, and the clumping cells without downgrowth. Because he found no downgrowths Bowen described the cases as being specific precancerous and so the condition became known as Bowen's precancerous dermatosis. Subsequent controls confirmed Bowen's diagnoses. After prolonged observation, however, Bowen found that downgrowth began to develop, i.e., the dermatosis became a true carcinoma of

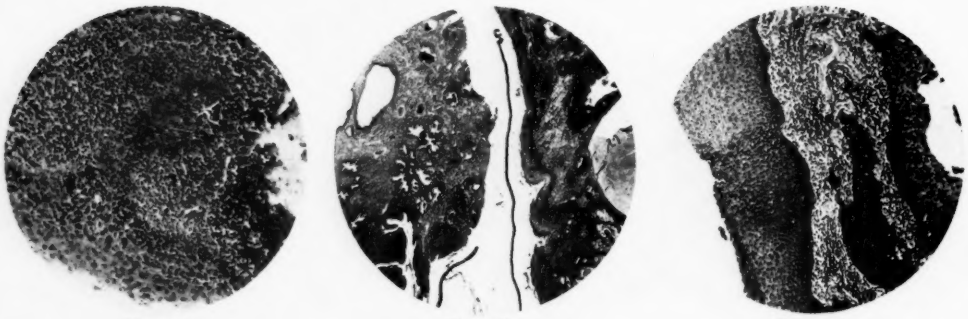


Fig. 11A. Fig. 11B. Fig. 11C.

Fig. 11. Case No. 27703. A, Scraping of the iodine negative area: A typical polymorphic epithelium with downgrowing projection which was diagnosed as carcinoma. (×67.) B, A beginning carcinoma of squamous epithelium at the external os. On the left is shown the inflammatory infiltration of the cervical tissue, on the right in the upper corner of the section a carcinomatous layer with a sharply defined demarcation. Two superficially placed projections are seen below the sharp border. The larger one has a triangular form with a space in the center. (×15.) C, The transition strongly magnified. (×57.)

the skin. This transition took place after a few months, in some cases after a few years, so that the hypothesis was accepted that Bowen's dermatosis was only a special form of carcinoma of the skin different from the other forms only in the extraordinarily long interval between development on the surface and in the deeper tissue; it was the Dutch dermatologist Caroll who laid down that idea most precisely. Bowen's dermatosis, that is, the form of carcinoma of the skin discovered by Bowen, commences its growth as a superficial layer but does not affect the deeper tissues. It refutes, too, as do our diagnoses as to the cervix, Ribbert's theory that carcinoma originating from epithelium misplaced in the deep, initiates in the deep. Histologically and cytologically Bowen's dermatosis corresponds with our diagnoses of the cervix.

A further evidence that these smallest carcinomata really are carcinomata is to be found in the fortunately rare clinical failures. A report of a characteristic case of this kind follows:

A woman, aged 46 years, was operated upon on account of tumors of the adnexa, and a hysterectomy was done. The cervix seemed quite smooth, showed no suspicion of cancer and macroscopic examination showed no erosion. I must add that this patient was examined and operated on in 1927 at which time we had formulated no special method for the early diagnosis of carcinoma of the cervix and had not attained sufficient experience to determine the histological aspect of the early stages. After systematic examination of the cervix a typical polymorphic celled, carcinomatous layer was discovered, with distinct demarcation, and free from glycogen. Within the cervical canal two small areas were noted in which the growth had begun to penetrate the deeper tissue. The wound healed by first intention and the patient was dismissed from the hospital after she had been given a short course of treatment for slight bladder trouble. She was free from complications for a long time, but after 4 years she returned to our clinic with the typical neuralgic pains in both legs and a carcinoma, almost the size of a fist, located in the small pelvis which could be easily palpated. In spite of total extirpation there probably was already formed a very small metastatic growth which caused the reappearance. Had we been able to diagnose carcinoma with certainty 4 years previously, the parametria would have been removed as well by Wertheim's method and the patient would have been given strong radiation after-treatment.

This case is strong evidence of the necessity for recognizing that the carcinomatous layer is carcinoma in an early stage. With our knowledge today of the appearance of an early stage carcinoma such a catastrophe could not occur (Fig. 9).

After we had succeeded in determining to our satisfaction what the appearance of earliest stages of carcinoma were like the question naturally arose as to how the earliest stages could be recognized clinically. By most careful comparison of the appearance of the macroscopic operative specimens with the appearance through the speculum it was found that to the naked eye these smallest carcinomata resembled small, white, opaque, dull, sometimes also slightly wrinkled, spots in the smooth white transparent epithelium of the cervix. That is exactly what has been described years ago by the French and English authors as "leucoplakia" and to which in more recent years Franqué and his pupil Hinselmann were the first to draw our attention. By comparing histologically numerous specimens of leucoplakia I was able to state that the great majority were carcinomatous layers but that there were instances in which while the patches appeared in the speculum examination as typical

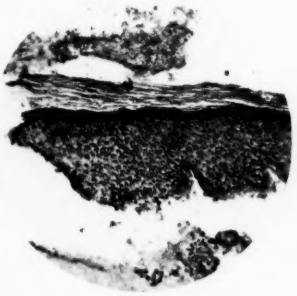


Fig. 12.

Fig. 12. Case No. 24186. Scraping: Real hyperkeratotic leucoplakia in prolapse. (×67.)

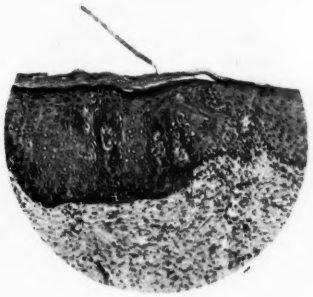


Fig. 13.

Fig. 13. Case No. 23875. Typical luetic leucoplakia with real hyperkeratosis. (×60.)

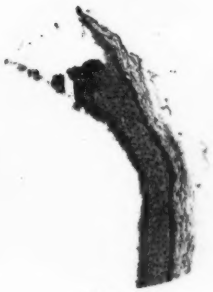


Fig. 14.

Fig. 14. Case No. 27318. Hyperkeratotic leucoplakia in leukæmia.

leucoplakia yet histologically they were only areas of hyperkeratosis. Such hyperkeratotic areas may originate either in the presence of prolapse when the epithelium is exposed to the drying influence of the air or in the presence of secondary syphilis. With the naked eye it is not possible to differentiate between carcinomatous leucoplakia and hyperkeratotic leucoplakia. With Hinselmann's colposcope by which the field can be strongly magnified and with which it is possible to examine the cervix precisely, several interesting morphological details regarding leucoplakias may be discovered, but the instrument does not make it possible to distinguish with certainty between carcinomatous leucoplakia and hyperkeratotic leucoplakia. This differentiation can be made only by histological examination.

The clinical diagnosis of leucoplakia is sometimes made difficult because the affected area is so small that it cannot be easily seen with the naked eye. The colposcope, however, often shows such areas more distinctly but as the colposcopic field of vision is relatively small, it is therefore necessary to examine carefully the whole cervix from the external os to the fornix in order to find such leucoplakic areas. An examination of this kind requires skill and time. In a crowded out-patient department it is hardly possible to examine a cervix for such minute detail and it is no doubt true that often cervices which appear to the naked eye as healthy, smooth, and unsuspicious, really harbor small incipient carcinomata.

Some method had to be found to locate the suspicious spots more easily and quickly. I discovered this method: vital staining with Lugol's solution. A startling revelation was made—the fact mentioned that normal epithelium of the cervix contains in its superficial layers glycogen yet no carcinomatous epithelium. This glycogen may be stained on the slide with Best's carmine and on the living patient with iodine potassium iodide solution. When the normal cervix is painted with ordinary Lugol's solution (iodine, 1; potassium iodide, 2; water, 300) the epithelium acquires in about half to one minute a mahogany brown color. However, in the areas in which some pathological process is present no brown staining takes place and the epithelium remains white and unstained. Thus, diseased spots in the epithelium, which escape the naked eye altogether and which can be found only by systematic and painstaking examination of the cervix with the colposcope are made visible in about a minute's time (Fig. 10). The technique used in painting the cervix is as follows: A cervical speculum is placed in the vagina and out of a small cup with a long spout about 10 to 15 cubic centimeters of Lugol's solution is poured and spread with a tampon over the cervix and left in the vagina for about a minute. The iodine solution is then sucked off with a tampon, the cervix and vagina are cleaned of the excess liquid, and gently wiped. It is very necessary that the solution should moisten the entire cervix and that no fold should prevent the entrance of the liquid as that might cause wrong diagnoses. If the epithelium shows an unstained spot we must be suspicious of cancer and the tissue here must be examined histologically. As a rule the presence of white, unstained epithelial spots which are free from glycogen may indicate four possibilities:

1. The presence of carcinomatous layers or incipient carcinomata (Fig. 11).

2. The presence of hyperkeratosis, a result of prolapse or descensus vaginæ (Fig. 12).

3. The presence of hyperkeratosis, a consequence of luetic infection (Fig. 13).

4. The desquamation of the upper layers of glycogenous epithelium which may have been caused by the touching of the cervix with sharp instruments or by the rough insertion of the speculum. Such traumatic desquamations are easily to be diagnosed by their form, as they resemble narrow sharp and straight line scratches.[1]

The decision as to the group in the terminology mentioned in which the unstained spots of the epithelium belong can be made with certainty only by microscopical examination. Colposcopic examination alone does not give sufficient evidence in all cases. To obtain material for the histological examination we do not use the V-shaped exploratory excision because the changes concern only the superficial epithelium and there is no need to make an excision into the deeper tissues. It is sufficient to scrape off a small piece of epithelium with a small spoon; often we may loosen the epithelium with the spoon and with a tissue forceps pull off a thin film. The advantage of this method is that it is necessary neither to proceed surgically nor to suture the wound made by excision. In our experience, skilfully removed pieces of epithelium are completely replaced by nature in 2 or 3 days and evidence of removal cannot be found.

Painting with iodine is of value in locating the newgrowth as long as it is in the stage of a carcinomatous layer. As soon as the growth ulcerates, the surface nearly always being necrotic stains brown with iodine and the method is therefore not helpful. On the other hand, ulcerated carcinomata are generally larger and more extensive and are therefore easily visible. In addition they are surrounded eventually by a line of demarcation of carcinomatous epithelium —a white superficial stripe around the ulceration. When a scraping is removed for diagnosis the white stripe should be scratched off and not the ulcerated part or the normal brown epithelium. The simple erosion is covered on the surface with inflamed connective tissue but later, during the first stage of healing, is covered with cylindrical epithelium. In both instances the erosion to the naked eye has a more or less dark red, dull velvety color. It becomes only slightly stained with iodine solution. It cannot be mistaken for the white superficial carcinomatous layers. The tissue for diagnosis, as already mentioned, should be taken from the white layers but never from within the dark red, eroded, or ulcerated parts.

[1] A few months ago we found a hyperkeratotic leucoplakia in a case of leukæmia, which is a very rare incidence or coincidence (Fig. 14).

In our clinic we use the same method to determine the extent of farther advanced carcinomata. It has been found that advanced carcinomata are surrounded by carcinomatous layers, the width of a finger, which are totally invisible to the naked eye. If when removing the carcinoma within the carcinomatous layer the operator fails to remove completely the carcinomatous layer itself, a recurrence is inevitable. I examined the postoperative specimens of a series of carcinomata apparently radically operated upon but which in spite of radial extirpation had reappeared. It was apparent that these carcinomata were surrounded by carcinomatous layers the greatest part of which had not been removed. This mistake can be avoided if the region of the carcinoma is painted with Lugol's solution before the operation, and if the operator observes strictly the limits of stained tissue, so that he removes all growth within the brown zone but by no means within the white carcinomatous area.

A further advantage of this method is that it is easy and does not require expensive instruments; in fact, no special instruments are needed and no special ability or technical training is required. It is not troublesome for the doctor or painful for the patient. Furthermore Lugol's solution is not expensive and the examination takes only 2 to 3 minutes—specular examination is prolonged by 2 or 3 minutes. It makes possible the diagnosis of a carcinoma of the cervix in its very first stage—a factor of much importance in securing absolute healing.

The histological diagnosis is made from the characteristic polymorphic and atypical cells of the epithelium. Up to the present time we have not known of a characteristic of carcinoma which would enable us unmistakably to diagnose it. We cannot be more exact in our definition of polymorphic and atypical tissue; the ability to recognize it is merely a matter of training and experience as are many other things in medicine. In medicine many diagnoses are made which cannot be supported by measurements, figures, or by an objective criterion as the evidence of parasites. The internist diagnoses penumonia because he finds dullness on percussion of the chest but he does not attempt to measure or try to represent the pneumonia in an objective form. He is able to diagnose it because of his medical experience and knowledge. Just as the experienced internist diagnoses pneumonia so we are able, through experience and study, to diagnose a carcinoma. Anyone who has seen a large number of cases of early carcinoma will have no difficulty in diagnosing the condition; experience in a number of

ases is the important factor in gaining knowl-dge—after the diagnosis has been made in 10 ases less difficulty will be experienced with the leventh and succeeding cases.

I consider the knowledge gained from accumu-ated clinical experience of great importance. We ave kept on file in our clinic each histological pecimen, whether positive or negative, and have ept in touch with each patient. As a result we ave in our histological museum many hundreds f slides on which the diagnoses are insured and have been proved by clinical after-examinations nd controls.

When an incipient carcinoma of the cervix is revealed by our method of painting with iodine we proceed at once to operate. In our clinic radiation is not used as a routine treatment in operable cases. If the patient is an elderly woman near or past the climacteric, we prefer to do a panhysterectomy rather than to use any other method. Only in young women who have tiny incipient carcinomata do we eventually use the method of amputation of the cervix, and we try to remove as much as possible of the cervical canal. The amputated cervix is cut in serial sections which are carefully examined to define the extension of the carcinomatous layer. If the examination shows that the removal was done at one place inside the carcinomatous layer, i.e., that the carcinoma was not completely and radically removed, then we proceed to extirpate the uterus and remove at the same time a part of the vagina. We do not consider it wise to do a mere excision of the carcinoma for the following reason: incipient carcinomata frequently extend high up into the cervical canal—even when the superficial examination shows outside the external os only a small carcinomatous area of a few millimeters in length and breadth, the histological examination may reveal deeper, high up in the cervical canal, a continuation of the typical carcinomatous epithelium. Mere excision therefore does not remove these parts and the reappearance of the tumor would most certainly follow.

Of course we cannot expect from a method more than it is worth. All circumstances considered some methods have been criticized because of failures when in reality the method was not applicable and good results could not be expected from its use. Iodine painting is a diagnostic method only in the sense that it draws attention to the pathological area; it does not, however, indicate the nature of the pathological process. The pathological diagnosis can be made only upon histological examination. It is true that the experienced surgeon will frequently be able to distinguish from the shape and the borderline of the white spots whether it is a case of carcinoma or only of hyperkeratosis. Painting with iodine proves only that the epithelium of the cervix is normal everywhere where it takes on the brown color; it does not prove that below the epithelium no carcinoma may be present. A carcinoma which begins in the cervical canal, infiltrates the connective tissue, and undermines the epithelium without reaching the surface cannot be diagnosed with the method of painting with iodine. As a general rule the deep seated carcinoma is extraordinarily rare; according to our experience the majority of cancers begin at the external os, or outside close to the external os. It is true also that carcinomata which fill up the cervical canal and infiltrate the cervix completely, almost always have small superficial proliferations which cover the surface outside the external os and when these are painted with iodine the presence of carcinoma is revealed. A very interesting case of this sort has been described by Preissecker.

A patient, 42 years of age, had a hazelnut sized carcinoma of the cervical canal. The carcinoma extruded in a tongue shaped proliferation of hardly 2 millimeters in length from the external os. The remaining part of the carcinomatous tissue was hidden in the cervical canal and in the wall of the cervix. Through the small proliferation the carcinoma was discovered with the help of iodine painting and colposcopic examination and the patient was urged to have an operation.

In case there is suspicion that a patient has carcinoma and the iodine painting test has proved to be negative, the carcinoma must be searched for in the subjacent parts of tissue by curettage of the cervical canal or by an excision of cervical mucous membrane of the external os. It would be altogether wrong to dismiss the patient without thorough examination. The diagnosis is made easier if the distinct demarcation is visible in the scraping, as will be found occasionally. It is recommended that the scraped off epithelium be submitted to glycogen staining, according to the Best method. The presence of large, typical vesicular, superficial layers of cells with an abundance of glycogen is positive evidence against carcinoma.

Several years ago the examination of the cervix by iodine painting was introduced in our clinic; in the last 2½ years it has been used systematically. During this time 553 scrapings were made, of which 140 were positive. Of course, there are among the positive cases a great number of scrapings from advanced carcinomata to verify the diagnosis and to verify the presence of the line of demarcation between the normal and the

carcinomatous layer. Forty-five patients with carcinomata were operated upon after positive diagnoses were made from scrapings. The total number of carcinoma operations during the same period of time was 90, and 19 of these were early carcinomata and operation was done upon the strength of the positive findings from examination of the scrapings. Six incipient carcinomata were found after routine histological examinations of tissue from patients who had been operated upon for other reasons; e.g., fibroids and other conditions. Of these 6 cases, not a single one had been examined by the iodine painting method or from the scrapings. For this reason they should not be included among failures of the iodine painting method. Our method is not used in certain cases, for instance, in those in which the cervix does not reveal a suspicion of cancer by speculum examination and the patient has been slated for total hysterectomy the next morning. In such cases, if a carcinoma should be found later, the necessary treatment of hysterectomy has already been performed.

Errors may creep in but it is a fact that the number of cases in which minute carcinomata are not discovered has become smaller: 4 years ago they were 3 per cent while today they are only 6 in 425 cases of hysterectomy, that is 1.41 per cent. In the 19 cases in which an early diagnosis was made and the patients operated upon, clinical examinations revealed no suspicion of cancer. It is remarkable that of these 19 women 8, that is 42 per cent, were less than 40 years of age. On the basis of the fact that with early diagnosis and immediate operation in minute, beginning carcinomata we have raised the percentage of complete cures to 90 or 95 per cent. I believe that it will be possible essentially to improve results in general in regard to carcinoma of the cervix. The method of iodine painting is easy and cheap; a doctor could examine 12 to 15 women with ease in an hour's time, or in a forenoon, 5 hours, 75 women. It should be considered a matter of course and it should be our duty to examine for incipient carcinoma each patient coming to us for treatment. It is a fact that in early carcinoma there is no subjective symptom which would force a woman to interview her doctor but we have found through our own experience that if patients are forced to see us because of other troubles, such as fibroids, affection of the tubes, discharge, etc., it is only through routine and thorough examination that the cancer is incidentally discovered. We still have today patients who interview the practitioner and seek treatment at hospitals because of some gynecological condition and who upon examination are found to be harboring an early carcinoma of the reproductive organs. This condition could be remedied if every woman would have systematically twice or three times a year a routine Lugol's test. It would then be possible to locate a carcinoma of the cervix in its earliest stages and treatment could immediately be instituted that would raise the percentage of complete healing to 95 or 100 per cent, especially with the improvement of postoperative X-ray treatment. Such a routine examination would not involve great expense and would not require especially instructed men.

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SKELETAL TRACTION WITH STEINMANN PIN

Results Obtained in Fifty-Two Cases of Fracture of Both Bones of the Leg[1]

MERRILL K. LINDSAY, M.D., F.A.C.S., and RAYMOND M. McKEOWN, M.D., New Haven, Connecticut

FRACTURES of both bones of the leg in its lower two thirds are observed with greater frequency as traffic accidents increase and, although the difficulties involved in the treatment of these cases have been met with varying degrees of success, still they remain a problem, requiring careful attention to detail in their management. For the past 5 years, Steinmann pin skeletal traction, followed by suitable plaster splints, has been used in this clinic in the treatment of compound and comminuted fractures of the distal portion of both tibia and fibula with very satisfactory results. It is our purpose to report 39 cases so treated with a brief consideration of the method itself, and the results obtained.

Dyas states that the Steinmann pin should not be credited to Steinmann, but rather to the hooks that Malgaigne used. Steinmann is believed to have used these prior to his use of a pin, while Heincke later added the blades and handles. Up to the present time, there can be no doubt that the pin has been used with reluctance, and that still there exists a widespread belief that the procedure is not without considerable danger. Farr for one states that skeletal traction possesses inherent danger, and that necrosis and infection are to be guarded against especially. Estes is of the opinion that plating is to be preferred to skeletal traction until such time as additional statistics show skeletal traction to be of more value than he thinks. In support of his contention he quotes from Sherman, Wagner, Auvray, and Eliason. Hitzrot says that pin skeletal traction, no doubt, has its proper place, but that he prefers to use open operative reduction in the treatment of fractures of both bones of the leg, while Wilson on the contrary differs from Hitzrot in that he believes skeletal traction in fractures of this type to be preferable to open operation. In addition, Wilson recognizes a well established fact that skin traction is usually out of the question, due to insufficient skin surface available. Scudder in his paper on the treatment of recent fractures of the long bones by operation, would try in all doubtful cases the non-operative method first, and holds that the honest use of skeletal traction will diminish the number of cases in which primary operation is required. From the difference of opinion available and the results seen in cases of fractures of both bones of the leg, not treated with skeletal traction, we can agree readily with the statement attributed to Sir Robert Jones that "If I were asked which fracture was the most difficult to reduce in the lower limb, I should say fracture of the tibia and fibula in the lower third."

From January, 1927, to September, 1931, we have treated 52 cases of fracture of both bones of the leg with Steinmann pin skeletal traction, of which we have satisfactory records of 39 (Table I).

TABLE I.—FIFTY-TWO CASES OF FRACTURE OF BOTH BONES OF THE LEG

1 to 39	Reported in detail in this paper, one case (No. 33–34) having fracture of both bones of both legs.
40	Record incomplete; union, however, apparently satisfactory.
41	Record incomplete; union, however, apparently satisfactory.
42	Record incomplete; union, however, apparently satisfactory.
43	Record incomplete; union, however, apparently satisfactory.
44	Record incomplete; case transferred elsewhere and roentgenograms not completed.
45	Record incomplete; unable to follow up patient after discharge.
46	Record incomplete; unable to follow up patient after discharge.
47	Record incomplete; roentgenograms incomplete.
48	Record incomplete; discharged against advice.
49	Record incomplete; roentgenograms incomplete.
50	Record incomplete; roentgenograms incomplete.
51	Record incomplete; roentgenograms incomplete.
52	Gas gangrene developed at fracture wound and mid-thigh amputation carried out.

In no case have we had either perceptible necrosis or osteomyelitis of the calcaneus through which the pin was inserted, while in all of the 39 cases we are reporting in detail at this time we have obtained satisfactory alignment without appreciable shortening. Functional union particularly has been satisfactory throughout. The procedure is not difficult, and with the usual hospital equipment, it is undertaken with ease, if a few simple principles are observed. A brief description of our technique is desirable to facilitate a more thorough interpretation of our results.

PROCEDURE

The point of introduction of the Steinmann pin into, and through, the calcaneus is of fundamental importance. The blood vessels and tendons about

[1]From the Department of Surgery, Section of Orthopædics, Yale University School of Medicine.

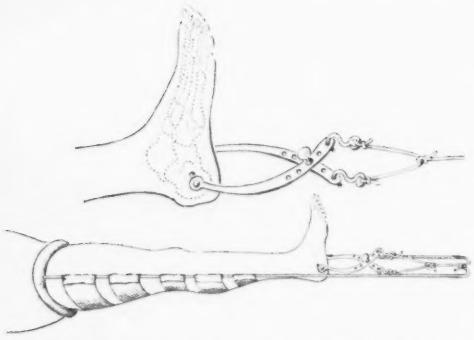


Fig. 1. Traction calipers and Thomas splint in place.

the ankle must be uninjured by the pin, and the joint surfaces must be avoided. In addition, the line of traction sought for is directly in the long axis of the leg, and this is best secured with the foot in a neutral position and right angle dorsiflexion. A point which meets these requirements is found 1 centimeter posterior and distal to the trochlear process of the calcaneus. The procedure of applying the pin in our cases was as follows:

The patient was anæsthetized as the nature of the case indicated. If co-operative, we frequently used a local anæsthesia. The preparation of the skin consisted of the application of benzine, ether, and tincture of iodine, the iodine being removed by sponging with alcohol. The extremity was

Fig. 3. Plaster boot in position.

supported with the foot in a neutral position and right angle dorsiflexion and the trochlear process of the calcaneus was located. Using this as a land mark, we made a skin incision in the long axis of the limb, 1 centimeter long, to center over a point 1 centimeter distal and posterior to the trochlear process. Before incision, the skin was drawn slightly toward the external malleolus in order that most of the incision would be distal to the point selected for inserting the pin, when the skin was subsequently released. In this manner, no tension in the skin resulted when the traction was applied later to the pin. With the aid of a hand drill or brace, the pin then was driven through the calcaneus at a right angle to the long axis of the tibia, as well as at a right angle to the long axis of the foot, until it could be felt beneath the skin on the medial aspect of the calcaneus. At this time, a second skin incision was made where indicated, to permit the pin to pass through. The traction calipers were attached to the projecting ends of the pin, and the traction rope temporarily

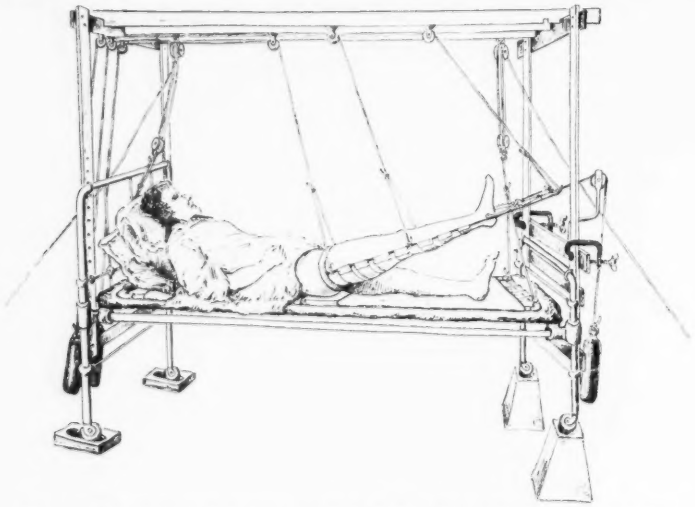
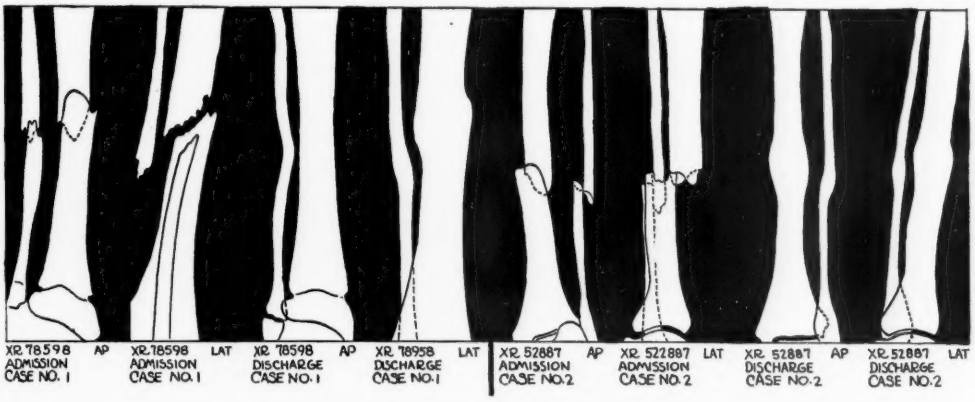


Fig. 2. Patient in bed, traction applied; Balkan frame suspending leg and bed elevated at foot.

Fig. 4. Delbet splint.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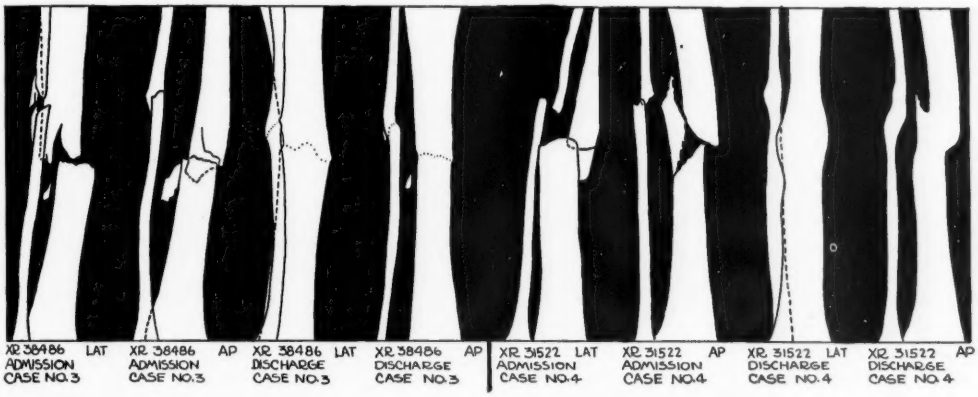
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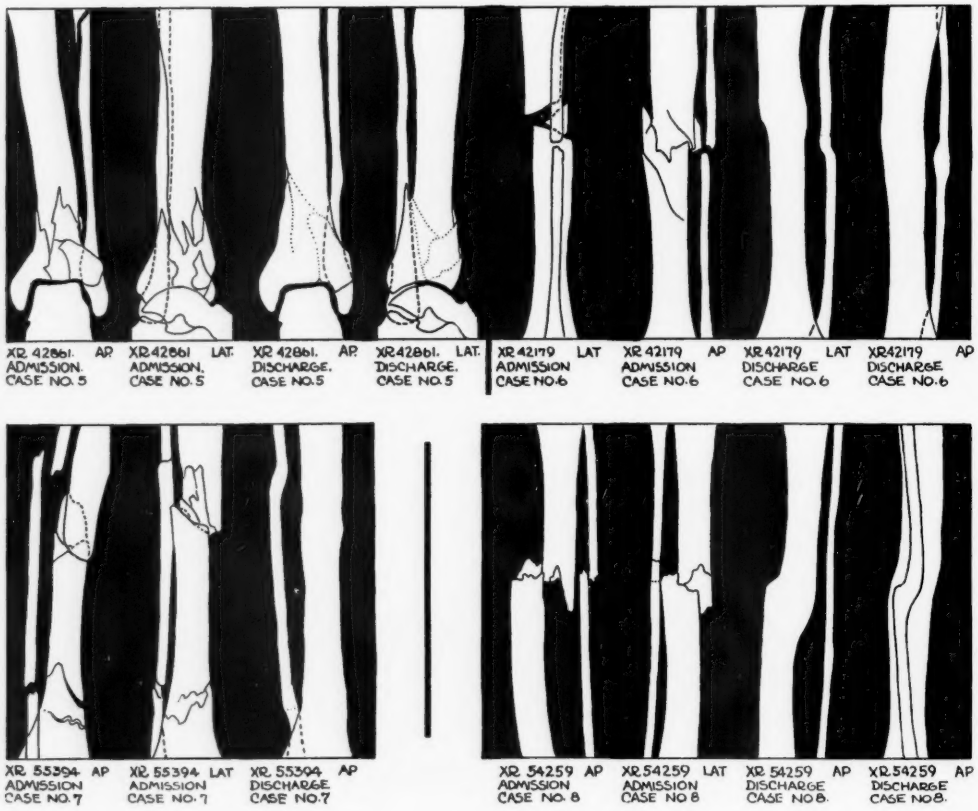
Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anæsthesia	Time in pin	Time in boot	Time in Delbet	Comments
1	78598	12 ♂	Auto accident	Complete oblique comminuted tibia and fibula both compound	1 hr.	Good	General ethylene	4 wks.	7 wks.	4 wks.	Wound healed slowly. Otherwise convalescence uneventful. End-result good
2	82870	21 ♀	Auto accident	Complete transverse tibia and fibula both compound	3 hrs.	Fair	General ethylene	6 wks.	5 wks.	4 wks.	Wound healed well, but callus slow in forming. Eventual end-result good
3	62536	37 ♂	Auto accident	Transverse comminuted tibia and fibula	4 hrs.	Fair	General ether	5 wks.	None	Delbet with steel rod support	Fibula spontaneously compounded 3rd day. Daily dressings. Good union by 16th week. Left at that time against advice
4	55762	41 ♂	Auto accident	Transverse fibula. Oblique comminuted tibia	32 hrs. at home previously	Very poor	General ethylene	6 wks.	8 wks.	None used	Walking calipers for 10 wks. Good functional result

PLATE I

fastened to the end of a Thomas splint (Fig. 1). The skin at its two points of contact with the pin was protected with sterile alcohol dressings. After the patient was returned to bed, traction of from 10 to 20 pounds, as the case necessitated, was applied with the leg in the supporting Thomas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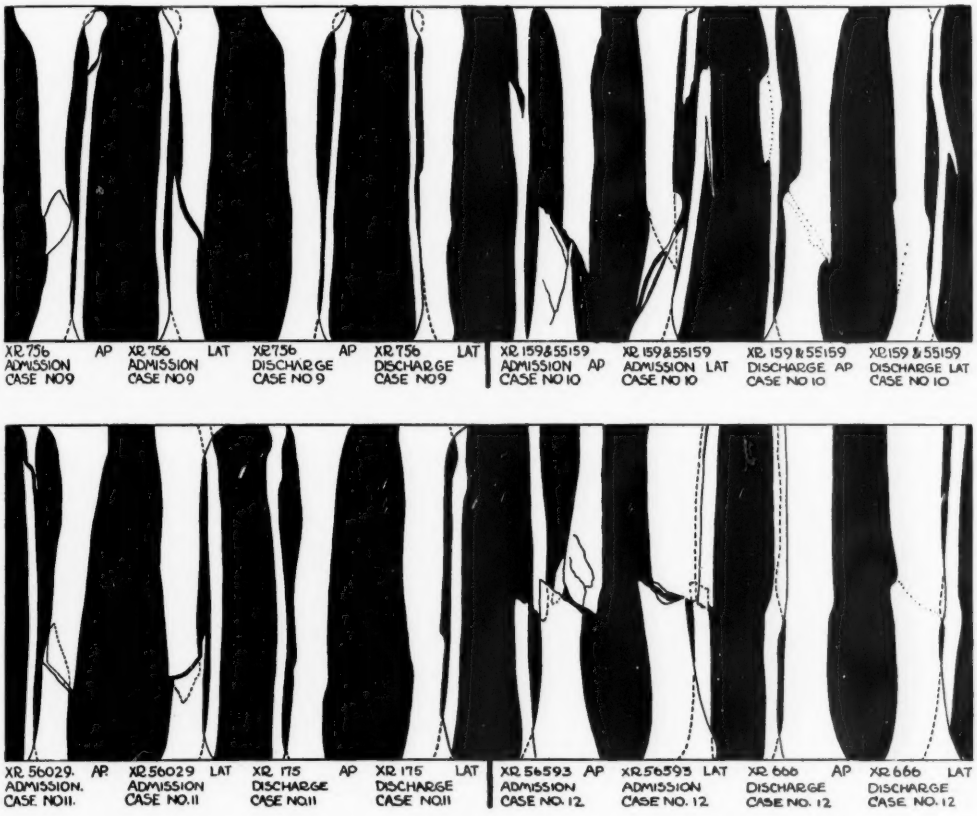
Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anæsthesia	Time in pin	Time in boot	Time in Delbet	Comments
5	7063	28 ♂	Fell from ladder	Impacted comminuted of tibia and oblique of fibula	5 hrs.	Fair	General ethylene	7 wks.	4 wks.	None used	Good end-results
6	70375	41 ♂	Auto accident	Complete transverse of tibia and fibula	16 days at home in full length plaster boot	Good	General gas and oxygen	5 wks.	4 wks.	3 wks.	Satisfactory
7	84457	48 ♂	Auto accident	Complete transverse comminuted lower and mid tibia and fibula	2 hrs.	Fair	General ethylene	4 wks.	4 wks.	4 wks.	Good. (Final lateral X-ray damaged)
8	83793	17 ♂	Auto accident	Complete transverse compound tibia and fibula	3 hrs.	Fair	General gas and oxygen	5 wks.	5 wks.	6 wks.	Good. Daily dressings to discharge. Weekly thereafter

PLATE II

splint in balanced suspension, from a Balkan frame. The foot of the bed was elevated about 12 inches to produce counter traction (Fig. 2). After 24 hours the position of the fragments was checked by roentgenograms to ascertain the success of the procedure, as well as the amount of weight required for future traction. Angulation was corrected readily throughout this stage by changing the supporting slings, or by using the pin as a lever as suggested by Dyas and others.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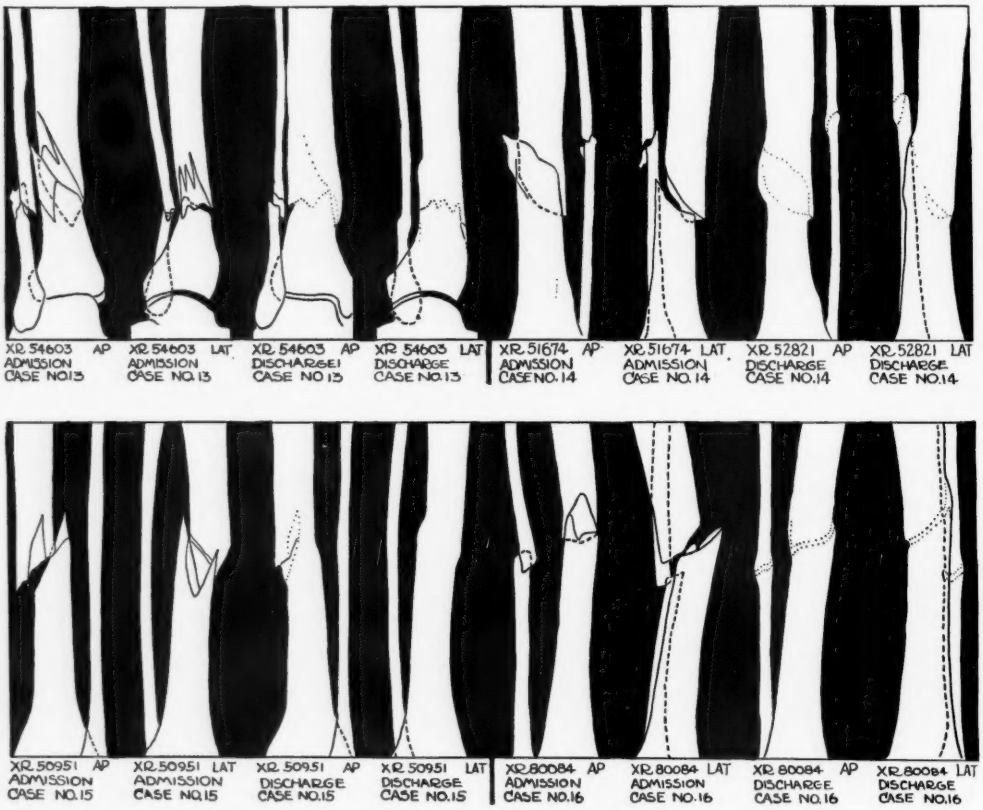
Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anæsthesia	Time in pin	Time in boot	Time in Delbet	Comments
9	10049	42 ♀	Fell on sidewalk	Complete oblique tibia. Complete spiral fibula	2 hrs.	Fair	Local novocain 2%	6 wks.	4 wks.	5 wks.	Good final results
10	84430	39 ♀	Fell on a tent floor	Complete oblique comminuted tibia and fibula	5 wks. Had been treated at home in full leg boot	Good	Local novocain 2%	3 wks.	4 wks.	4 wks.	Slight anatomical malposition. Good functional result
11	95022	23 ♂	Auto crank struck shin	Complete oblique tibia and fibula	4 hrs.	Good	General gas and oxygen	4 wks.	7 wks.	5 wks.	Good end-result
12	95259	22 ♂	Football	Complete oblique tibia. Complete transverse fibula	1 hr.	Good	Local novocain 2%	4 wks.	8 wks.	None used	Good anatomical and good functional results

PLATE III

In the case of compound fractures, daily dressings were done as indicated, and the ease with which this can be accomplished as compared with fractures treated in casts is decidedly advantageous.

By the fourth or fifth week, there usually was sufficient fixation of the fragments to warrant removal of the pin. A long plaster boot from midthigh to the tip of the toes was applied with suffi-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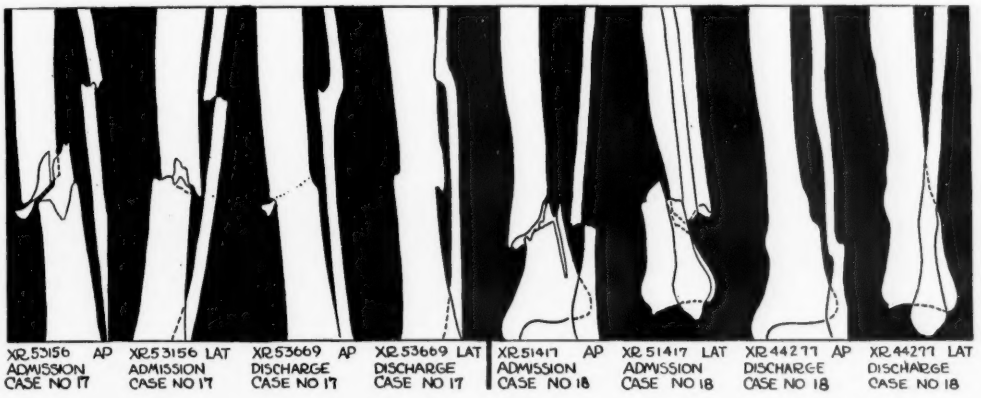
Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anæsthesia	Time in pin	Time in boot	Time in Delbet	Comments
13	50074	34 ♂	Auto accident	Complete oblique comminuted tibia and fibula	2 hrs.	Poor	General gas and oxygen	3 wks.	7 wks.	6 wks.	Developed delirium tremens. Quieted by drugs. Callus not well formed until third mo. History of syphilis. End-result good
14	82104	41 ♂	Auto accident	Compound comminuted	1 hr.	Good	Local novocain 2%	5 wks.	5 wks.	3 wks.	Very satisfactory end-result
15	81665	56 ♂	Auto accident	Spiral oblique tibia. Transverse fibula (fibular fracture in upper ⅓ omitted by mistake)	2 hrs.	Good	General ethylene	5 wks.	4 wks.	2 wks.	Good end-results
16	80084	17 ♂	Fell off a ladder	Compound oblique fracture of tibia and fibula	5 hrs.	Good	General ethylene	5 wks.	4 wks.	3 wks.	Good end-result

PLATE IV

cient flexion at the knee to prevent rotation of the leg (Fig. 3). The patient was permitted to go about in a wheel chair for 3 or 4 weeks, at which time a Delbet splint was substituted (Fig. 4), and active motion of the knee and ankle was started. After painless motion in these joints had been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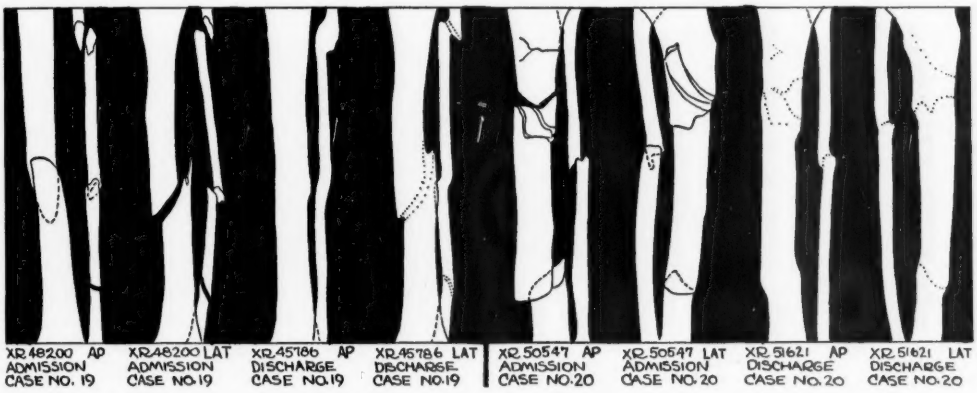
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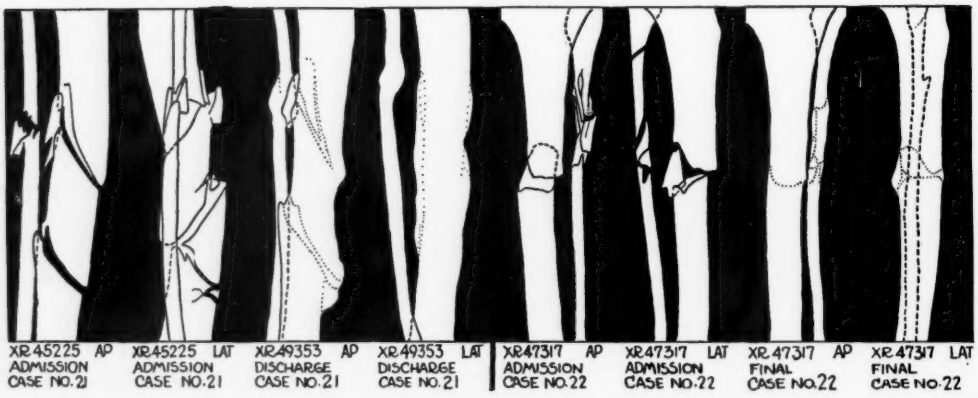
Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anæsthesia	Time in pin	Time in boot	Time in Delbet	Comments
17	82300	34 ♂	Auto accident	Oblique comminuted tibia. Transverse fibula	2 hrs.	Good	Local novocain 2%	4 wks.	3 wks.	None used	Good end-results
18	71576	17 ♂	Fell beneath moving motorcycle	Compound comminuted tibia. Oblique fibula	4 hrs.	Good	General gas and oxygen	6 wks.	5 wks.	None used	In walking caliper that wound might be dressed. Good end-results
19	72462	26	Auto accident	Spiral of tibia. 3 fractures of fibula. An upper oblique, middle oblique, and lower oblique	3 hrs.	Good	General ethylene	5 wks.	5 wks.	3 wks.	Eventually (by 4th month) good end-results. Had massive collapse of right lung for 12 days. Without sequelæ
20	81447	62 ♂	Auto accident	3 fractures of tibia; upper fissured; middle transverse comminuted; lower oblique. Oblique fibula	20 hrs.	Poor	General gas and oxygen	4 wks.	5 wks.	4 wks.	Good end-result

PLATE V

accomplished, the patient was encouraged to walk in a "walker" or on crutches, and swelling of the foot and leg, while walking, was prevented by bandaging the leg from toes to the knee with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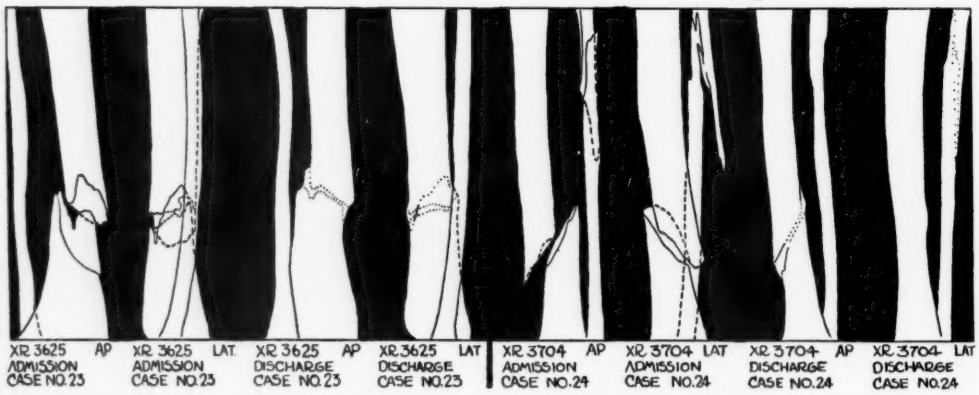
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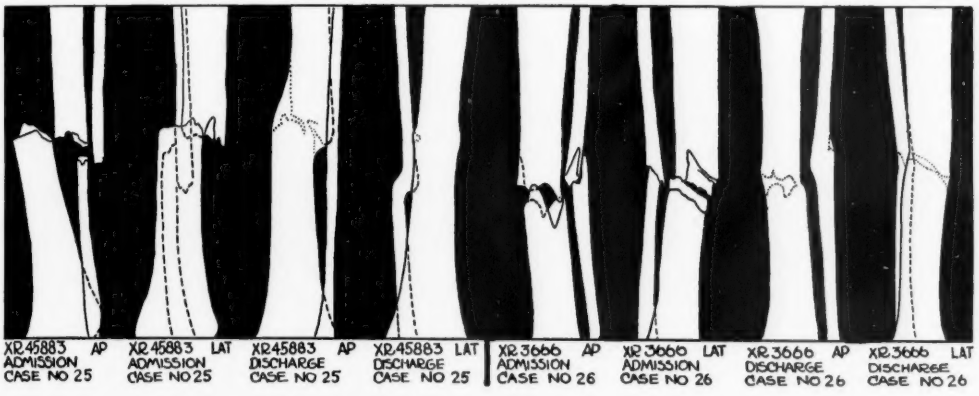
Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anæsthesia	Time in pin	Time in boot	Time in Delbet	Comments
21	72092	36 ♂	Auto accident	2 spiral comminuted fractures of tibia. One oblique comminuted of fibula	48 hrs.	Poor	Local novocain 2%	7 wks.	6 wks.	4 wks.	Delirium tremens on admission. Controlled by sedatives. End-results good
22	40636	56 ♂	Auto accident	Compound comminuted oblique of tibia and fibula	10 hrs.	Poor	General ethylene	4 wks.	5 wks.	4 wks.	Badly shocked on admission. Rallied rapidly. End-results functionally good
23	A2490	65 ♂	Auto accident	Compound comminuted oblique of tibia. Questionable fracture of upper fibula does not show in plate	2 hrs.	Good	General gas and oxygen	4 wks.	5 wks.	5 wks.	Also anterior dislocation of shoulder. Wound healed well under daily dressings. End-result good
24	A2540	46 ♂	Fell off a dock	Oblique of tibia. Comminuted oblique of fibula	2 hrs.	Fair	General ethylene	5 wks.	4 wks.	5 wks.	End-results good. Callus somewhat slow in forming

PLATE VI

an elastic bandage. The Delbet splint was removed when the roentgenograms showed abundant firm callus.

RESULTS

Our results with this procedure in 39 cases of fracture of both bones of the leg, associated with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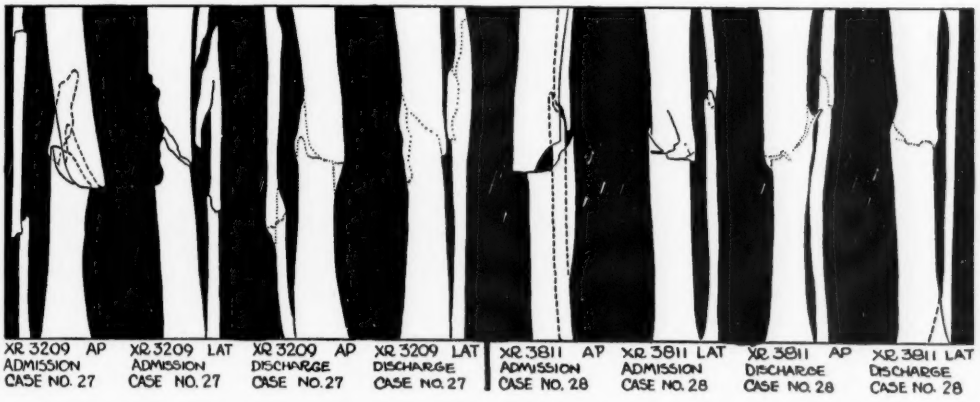
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Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anæsthesia	Time in pin	Time in boot	Time in Delbet	Comments
25	22528	16 ♀	Sledding accident	Transverse compound tibia and fibula	20 hrs.	Fair	General ethylene	4 wks.	5 wks.	3 wks.	End-results good
26	79184	19 ♂	Motor-cycle accident	Transverse comminuted tibia and fibula	2 hrs.	Good	General ethylene	4 wks.	5 wks.	None used	Crutches with leg in boot used. Then an elastic bandage. Final results good
27	36296	18 ♂	Motor-cycle accident	Compound comminuted tibia. Two transverse fractures of fibula	4 hrs.	Good	General ethylene	4 wks.	6 wks.	None used	Elastic bandages and crutches used instead of Delbet. Physiotherapy. End-results good
28	A2656	44 ♂	Auto accident	Compound comminuted oblique tibia and fibula	1 hr.	Good	General ethylene	4 wks.	6 wks.	5 wks.	Good end-results

PLATE VII

overriding or shortening, are shown in Plates I to X. They have been so satisfactory that we rarely find occasion to use any other method except in unco-operative patients and very young children.

We believe that the results of treating the cases we have reported are of sufficient merit to warrant its indefinite continuance in this clinic. The fear of infection and necrosis, we do not believe need

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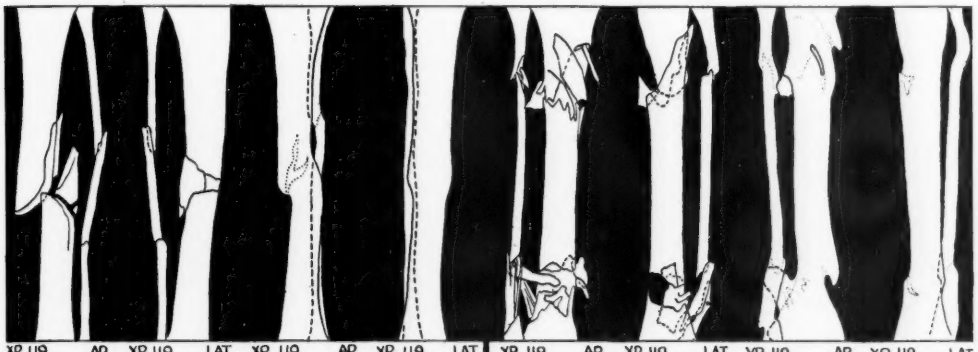
Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anæsthesia	Time in pin	Time in boot	Time in Delbet	Comments
29	84512	28 ♂	Thrown from a horse	Complete transverse of tibia and fibula	3 hrs.	Good	Local novocain 2%	4 wks.	4 wks.	5 wks.	Good end-result. Lateral X-ray damaged
30	A1830	30 ♀	Fell down stairs	Complete oblique comminuted tibia. Fibula complete oblique	2 hrs.	Good	General ethylene	4 wks.	4 wks.	None used	Cast bivalved and patient given crutches. Final result good
31	84234	48 ♂	Auto accident	Complete oblique of tibia and fibula	1 hr.	Fair	General ethylene	4 wks.	4 wks.	5 wks.	Good end-result
32	27911	14 ♂	Auto accident	Spiral comminuted of tibia. Two transverse fractures lower third fibula	4 hrs.	Good	General ethylene	4 wks.	5 wks.	9 wks.	Good end-result

PLATE VIII

be realized when ordinary orthopedic surgical technique is observed. The belief that pain is associated with such traction we have never found justified when a proper incision was made to prevent tension on the skin distal to the pin. The patient soon becomes adjusted to the method, and it was the exceptional case that was not comfortable throughout.

The treatment by this procedure of patients with compound fractures we have found comparatively simple, and assuredly more satisfactory than by any form of splinting. The plating of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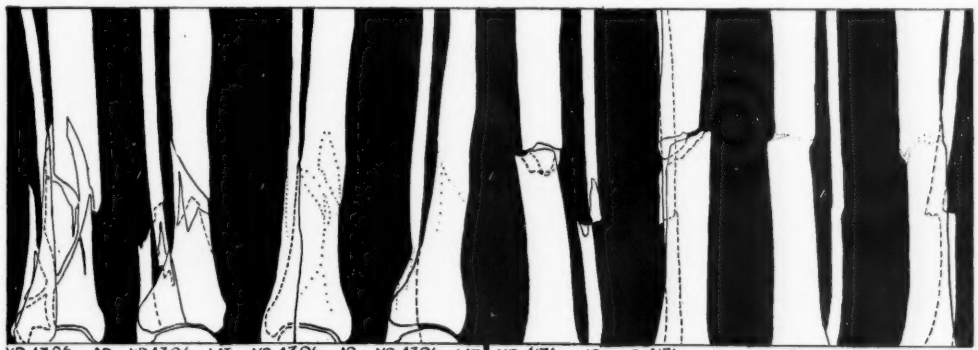
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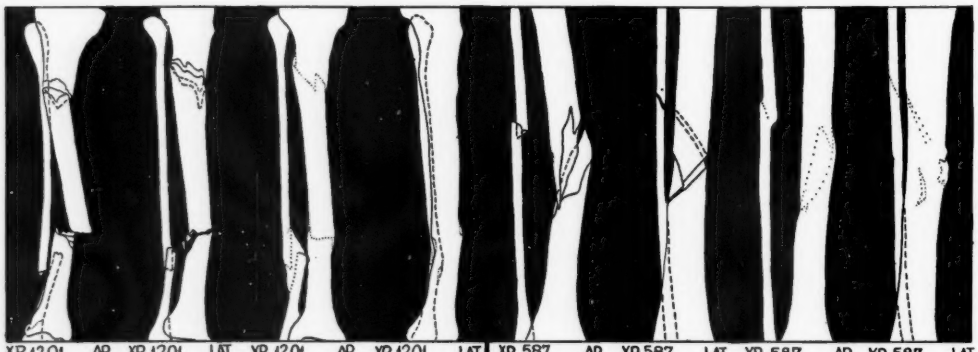
Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anæsthesia	Time in pin	Time in boot	Time in Delbet	Comments
33	95440	58 ♂	Auto accident	Both right and left leg fractured. Right: oblique comminuted tibia. Double transverse fibula	2 hrs.	Fair	General gas and oxygen	4 wks.	10 wks.	6 wks.	Came in shock. Rallied rapidly. Daily alcohol dressings. End-results good
34				Left: double transverse comminuted tibia and fibula. Both compounded							
35	97227	58 ♂		Oblique comminuted both tibia and fibula	2 hrs.	Good	General gas and oxygen ether	4 wks.	8 wks.	None used	Cast bivalved at end of 6th week. Used crutches. Good results
36	A2998		Ran into a truck while on motor-cycle	Transverse fracture of both tibia and fibula	2 hrs.	Fair	General gas and oxygen	4 wks.	6 wks.	4 wks.	Final result good

PLATE IX

compound fractures of this type we dismiss with the statement that it introduces an unnecessary foreign body, only complicating an already complex problem. The method we use appears to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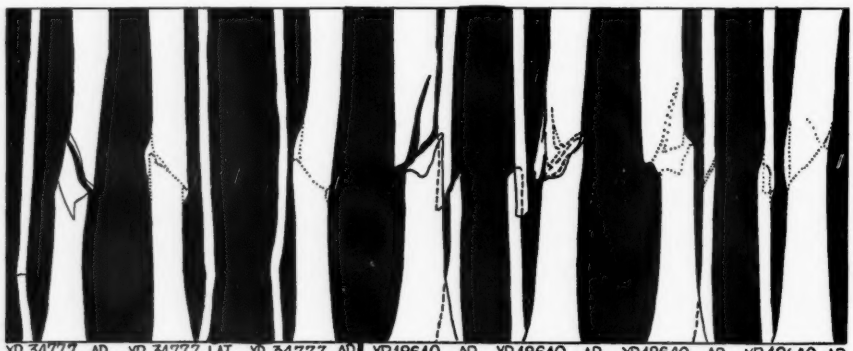
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Drawings by - ROBERT L. FELDMANN, M.D.

Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anæsthesia	Time in pin	Time in boot	Time in Delbet	Comments
37	A750	47 ♂	Struck by a log	Double of tibia. Upper: complete oblique comminuted. Lower: transverse comminuted. Fibula complete transverse. Both compounded	2 hrs.	Fair	General ethylene	4 wks.	3 used 1st on 2 days 2nd on 4 wks. 3rd on 1 wk. and then bivalved	None used	Callus slow in forming. Angulation needed constant attention. Wounds healed slowly. End-results good
38	84087	60 ♂	Fell down stairs	Compound spiral of tibia. Simple transverse of fibula	4 hrs.	Fair	General ether	7 wks.	6 wks.	3 wks.	Tibial area developed low grade osteomyelitis in 3rd wk. Cleared completely by maggots. End-results good
39	54081	9 ♂	Auto accident	Oblique comminuted tibia. Simple transverse fibula	3 hrs.	Fair	General ethylene	4 wks.	2 wks.	None used	Walking calipers used after boot. Good end-results
40	33613	30 ♂	Auto accident	Complete transverse comminuted tibia and fibula	2 hrs.	Good	General gas and oxygen	4 wks.	5 wks.	4 wks.	End-result good

PLATE X

meet every requirement in cases of great comminution where internal fixation is unsatisfactory or impossible. It may be applied quickly and safely under local anæsthesia when a more prolonged procedure or general anæsthesia is contra-indicated.

CONCLUSION

Skeletal traction, in the form of the Steinmann pin, is of considerable value in the treatment of fractures of both bones of the leg as we have found in the 39 cases reported from this clinic. The method is simple and safe within the limitation of the operator's technique.

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RESECTIONS OF THE COMMON AND HEPATIC BILE DUCTS AND AMPULLA OF VATER FOR OBSTRUCTING LESIONS

Results in Thirty Cases[1]

WALTMAN WALTERS, M.D., F.A.C.S., Rochester, Minnesota
Division of Surgery, The Mayo Clinic

I SHALL present here my results in 30 cases following resection of the common and hepatic bile ducts and of the ampulla of Vater for relief of obstructive jaundice due to strictures and tumors.

The operative procedures can be divided into five groups: (1) hepaticoduodenostomy, choledochoduodenostomy, and cholecystduodenostomy; (2) excision of the stricture or tumor, with anastomosis of the ends of the duct; (3) plastic operation for localized stricture, consisting of longitudinal incision of the stricture followed by transverse closure after the method of a Heineke-Mikulicz pyloroplasty; (4) transplantation of external biliary fistula, established when a sufficient amount of common or hepatic duct did not remain to enable anastomosis of the duct and the duodenum; and (5) resection of the ampulla of Vater for carcinoma.

Although the indications for these procedures will be considered later in detail, several conclusions have been drawn from a study of these cases and they will be enumerated here rather than at the termination of the paper. Thus any who have had experience in similar cases will be enabled to compare these conclusions with their own and to analyze the arguments in favor of each procedure. These conclusions are:

1. If sufficient normal duct remains above the stricture to enable its accurate anastomosis without tension to an opening made in the duodenum, thus obtaining union of mucous membrane to mucous membrane, results will be excellent, provided the liver is in satisfactory condition. Failure to obtain such a result can be attributed directly to inaccurate anastomosis, to severe infection of the parenchyma of the liver, or to infection in the walls of the biliary tract itself; infection in either of the structures mentioned may be accompanied by sand-like calculi within the biliary passages.

2. If the stricture or tumor is small, or is situated directly adjacent to the liver, with normal duct both proximal and distal to the stricture or tumor, excision of the lesion, with subsequent direct anastomosis of the ends of the duct, probably will be a satisfactory procedure, and can be expected to be followed in most cases by good results. Such is not usually the case, however, if the scarred portion is merely incised and allowed to remain, even though the lumen of the duct at this point is increased by a plastic procedure of the Heineke-Mikulicz type. This may be explained by the fact that the remaining scar tissue continues to contract.

3. If the amount of duct which remains exterior to the liver is not sufficient to allow of either procedure, an external biliary fistula can be established and later coned out and transplanted into the stomach or duodenum. This may be expected to be followed with good results in some instances and fairly good results in others.

4. The frequency with which small tumors of the ampulla of Vater cause obstructive jaundice should not be forgotten. Since the tumor is usually small and of low degree of malignancy, producing symptoms early and metastasis late, it

[1]Read before the Southern Surgical Association, White Sulphur Springs, West Virginia, December 8 to 10, 1931.

thereby lends itself readily to transduodenal removal.

HEPATICODUODENOSTOMY, CHOLEDOCHODUODENOSTOMY AND CHOLECYSTDUODENOSTOMY

Hepaticoduodenostomy or choledochoduodenostomy has been carried out in 15 cases (Tables I and II, and Case 26), and cholecystduodenostomy (Case 14), because of the greater ease of attachment to the duodenum without tension, in 1 case. Visible jaundice was present in all; the value for bilirubin varied from 1.2 to 17.4 milligrams for each 100 cubic centimeters of serum. With two exceptions, all the patients had been operated on for disease of the biliary tract before they came to the clinic, the gall bladder, according to the history, having been removed or drained. In 2 cases in which operation had been performed at the clinic for stones of the common duct, there was marked infection throughout the biliary tract and especially in the walls of the duct itself; evidences of recurring obstruction of the common duct (due to stricture) developed 4 years later in 1 case (Case 1) and 1 year later in the other (Case 5 in Table I). In all 16 cases, the duration of the jaundice varied from 4¼ days to 2 years, and the obstruction manifested itself from as short a time as immediately following operation to 5 years after operation (Tables I, II, and VI).

Excellent results are known to have followed operation for at least 5 years in 1 case, 4 years in 1 case, 3 years in 2 cases, more than 1 year in 2 cases, and less than 1 year in 2 cases. The index of excellence has been that the patients have regained their health subsequent to operation and have had no further evidence of biliary obstruction, whether pain, jaundice, or chills and fever.

Two of the patients reported that they were in good health and free of constant jaundice, but that at times they had pain, transient jaundice, or fever of short duration (Table II). In one of these cases (Case 11) jaundice had been present 3 months before hepaticoduodenostomy, cirrhosis of the liver graded 3+ was noted at operation, and a very short fringe of hepatic duct remained above the stricture. Further evidence of hepatic injury in this case was lengthening of the coagulation time to 16 minutes. In the other of these 2 cases (Case 12) bile drained externally for 6 months before hepaticoduodenostomy, and in the intrahepatic ducts were found sandy, granular stones. In this instance, too, only a fringe of duct remained for anastomosis. Another patient (Case 9) underwent choledochoduodenostomy in 1926, at which time intrahepatic stones were noted, in addition to the stricture. In 1927, a plastic operation was done at the stoma made at choledochoduodenostomy and again stones were found. In 1930, I explored the anastomosis and the ducts. The anastomosis was in excellent condition, but in both the common and hepatic ducts were small granular stones. This patient continues, at times, to have occasional biliary colic. The value for bilirubin recently was 2 milligrams for each 100 cubic centimeters of serum, and on test of hepatic function, retention of phenoltetrachlorphthalein was graded as maximal (grade 4), but on duodenal drainage a normal amount of bile of normal color was obtained. In other words, the condition of the patient, her symptoms, and the obstruction are results of hepatic and intrahepatic infection with formation of stones and are not due to contracture of the hepaticoduodenal anastomosis. In another case (Case 13), in which the value for bilirubin was 7.5 milligrams for each 100 cubic centimeters of serum, at operation stricture of the hepatic and common ducts extended almost to the hilum of the liver, and only a fringe of normal duct remained above for anastomosis. After operation the patient was returned to the care of her family physician, and it was recommended that the T-tube remain in place for 1 year because of the inaccuracy of the anastomosis. It was advised, further, that should evidences of obstruction again occur it would be necessary to establish an external biliary fistula which later could be transplanted into the duodenum. The patient was free from evidence of biliary obstruction for a year, when she again began to have intermittent attacks of colic, chills, and fever, without jaundice. She has gained in weight, but states that her condition is not satisfactory. One of the most interesting cases of the group, from the standpoint of showing the effect of hepatic injury on postoperative progress, is that of a young woman on whom I operated September 30, 1926 (Case 8), at which time she was deeply jaundiced and had been so for 3 months. I performed choledochoduodenostomy and she was well for 6 months subsequent to the operation; then she began to have jaundice, chills and fever, but no pain. Examination gave evidence of an enlarged liver and some jaundice of the skin, but a normal amount of bile was obtained by duodenal drainage. While she was under observation ascites developed, which responded to the use of mercurial diuretics. She returned October 3, 1927. She was not jaundiced, and there was no ascites, but an enlarged liver was noted. July 10, 1931, 5 years following operation, she returned to the clinic with severe jaundice and an enlarged, palpable liver. She died from bronchopneumonia July 21, 1931.

TABLE I.—HEPATICODUODENOSTOMY

Case	Age and sex	Serum bili-rubin	Date of operation	Symptoms	Previous operations	Postoperative progress
1	63 M	17.4	5-15-26	Jaundiced 4.5 days	Cholecystostomy and choledocholithotomy, 1922	Excellent from 1927 to 1931. No tube.
2	50 M	3.3	8-2-28	Jaundiced 2.5 months	Cholecystectomy (elsewhere), 1927	Excellent from 1928 to 1931. No tube.
3	46 M	3.8	5-29-30	Intermittent fistula with jaundice and fever since operation	Cholecystectomy (elsewhere) Nov., 1929*	Excellent in 1931.
4	32 F	1.4	9-27-30	Intermittent colics and jaundice for 9 months	Cholecystectomy (elsewhere), 1927	Good in 1930; excellent in 1931.
5	54 M	7.4	6-16-31	Intermittent colics and jaundice, 3 months; pruritus	Cholecystectomy and choledocholithotomy, 1925; dilation of stricture of hepatic duct, 1926; choledochostomy, 1927; choledocholithotomy, 1929; hepaticoduodenostomy (stones), 1931	Excellent, 11-20-31.
6	49 F	1.2	10-13-31	Pain in right upper quadrant for 2 years	Cholecystostomy, 1920; cholecystectomy, 1923; adhesions (elsewhere), 1923	

*Had three intrahepatic stones each approximately 1 cm. in diameter.

As has been said, one of the 16 patients (Case 14) was subjected to cholecystduodenostomy, for it was believed to be the preferable procedure. This patient had had biliary colic, chills, and fever for 2½ years, and had been confined to bed for a year prior to her operation in January, 1926. This patient I presented at the staff meeting of the clinic on two occasions subsequent to her operation as an example of what seemed clinically to be hepatic regeneration (8). In the year subsequent to operation, jaundice would occur at infrequent intervals. During the early part of 1928 she had no further jaundice, her stools were normal, and she had no pain. In July, 1928, however, she had slight hæmatemesis, but on March 4, 1929, she was found to be in good condition except that retention of phenoltetrachlorphthalein was graded 2. She continued to be well until the early part of this year (1931) when she died from sudden hæmorrhage, apparently the result of rupture of œsophageal varices.

EXCISION OF LOCALIZED STRICTURE OR OF TUMOR, WITH DIRECT ANASTOMOSIS

I have used this method in 4 cases (Table III and Case 27 in table VI), in 3 of stricture and in 1 of neurofibroma. T-tubes were used in the anastomosis in 3 of the cases and removed from 6 to 8 weeks subsequent to operation in 2. This method has been used when the stricture was localized, was small in extent, involved the ducts very near to the liver, and the duct was patent and of normal appearance distal to the stricture. Excellent results have been obtained in each of these cases; more than 3 years and 9 months have elapsed since the first patient was operated on (Table III). The fourth patient died 7 days after operation from acute suppurative cholangeitis and hæmorrhage (Case 27).

The patient with the neurofibroma (Case 17) has been reported in detail previously (3). Suffice to say, however, that after removal of the tumor the ends of the hepatic ducts were anastomosed to the distal end of the common bile duct over two small T-tubes, one of which was removed in 4 weeks, and the other in 8 weeks.

Considering the excellent results obtained in the 3 cases in this group, one may well ask why such a method is not preferable to anastomosing the duct and the duodenum. The answer is that it may be preferable when practicable; yet, I have found it applicable in but 4 of the 29 cases, due to the large extent of the stricture, and furthermore, I have had the impression that over long periods of time, there has been a greater tendency to recurrence of the obstruction at the site of such anastomosis than occurs following choledochoduodenostomy. Discussion of this point should be particularly interesting.

INCISION AND PLASTIC ENLARGEMENT OF THE STRICTURED PORTION

I have distinguished between this method and the preceding one, because in the former the fibrotic portion is completely removed whereas in the method now to be described, the fibrosed portion remains, and later may distort or again obstruct the anastomosed portion by continued contracture. This latter method was used in my earliest cases, and although one patient was free from symptoms of obstruction for 3 years, such symptoms then returned. Another patient has had no evidence of biliary obstruction over a period of 1 year, whereas a third patient has

TABLE II.—HEPATICODUODENOSTOMY AND CHOLECYSTDUODENOSTOMY

Case	Age and sex	Serum bilirubin	Date of operation	Symptoms	Previous operation	Operative findings	Postoperative progress
7	64 F	4.7	6–30–25	Biliary fistula; slight jaundice	Cholecystectomy (elsewhere), 1923	Stricture at level of liver; inaccurate anastomosis	Left hospital in good condition; died at home 20 months later; colic and jaundice.
8	25 F	13.6	9–30–26	Jaundice and colic, 3 months	Cholecystectomy (elsewhere), 1926	Liver hypertrophied and color of Paris-green	Jaundice, chills, fever, and enlarged liver for 6 months; 10–3–27 no jaundice or ascites, large liver; 7–10–31 jaundice, chills, fever, and ascites; 7–21–31 died bronchopneumonia.
9	36 F	2.6	5–21–26 4–12–30	Constant jaundice, colic, and fever since childbirth, 7–4–28	Choledochoduodenostomy, 1926; plastic and choledocholithotomy, 1927 and 1930	Intrahepatic stones, 1926; intrahepatic stones, 1927; intrahepatic stones, 1930; anastomosis normal	5–17–30 dismissed, T-tube slipped out, followed by intense colics, jaundice, and itching; July, 1930 and Aug., 1931 serum bilirubin graded 2, liver function graded 4.
10	44 F	6.3	8–2–27	Jaundice for 2 years; postoperative biliary leakage	Cholecystostomy, 1913; cholecystectomy (elsewhere), 1923	Stricture of lower third of common duct; choledochoduodenostomy	Excellent until 1931, then occasional colic, jaundice, and fever.
11	63 F	3.3	3–29–28	Jaundice, 3 months	Cholecystectomy (elsewhere), 1926	Cirrhosis graded 3+; short hepatic duct; coagulation time 16 minutes	Excellent in 1928; chills and fever in 1929; chills, fever, jaundice, and colics in 1931.
12	25 F	2.1	7–4–29	Biliary drainage, 6 months postoperative; intense jaundice and colics; 12 pounds weight lost	Cholecystectomy (elsewhere), 1928	Granular, sandy, cholesterol stones in hepatic ducts; fringe of hepatic duct	T-tube removed Oct., 1929; Nov., 1929 colic and slight jaundice; 10–5–31 excellent; occasional colic.
13	31 F	7.5	4–17–30	Jaundice and pain, 2 weeks	Cholecystectomy and T-tube in common duct (elsewhere), 1929	Stricture of common duct nearly to liver; fringed duct; purulent bile; T-tube for 1 year	Sept., 1931 pain, chills, and fever; no jaundice; condition not satisfactory.
14	43 F	3.8	1–4–26	Jaundice and colics, 2.5 years	Cholecystostomy (elsewhere), 1923	Cholecystoduodenostomy	Good in 1928; July, 1928 slight hæmatemesis; good until 4–13–31 died of hæmorrhage of œsophagus.
15		1.7	4–20–26	Biliary fistula, 3 months; postoperative; intermittent colic, fever, and jaundice of week's duration for 3.5 years; 59 pounds weight loss	Cholecystectomy (elsewhere), 1922; adhesions (elsewhere), 1923	Common duct stricture to within 8 mm. of liver with stone 2 mm.; hepaticoduodenostomy over catheter	Catheter held in place by silk thread to exterior until 6–14–26; catheter passed through intestines spontaneously 8–4–26; Sept., 1926 biliary obstruction, pain, fever, jaundice; attack lasted 2 days, jaundice 10 days; Oct., 1927 no attacks last 9 months; Aug., 1928 no attacks, good condition; died suddenly Jan., 1930 (hæmorrhage?); sick 2 days.

reported continued good results from operation for over a period of 5 years. I have not the faith in this procedure that may be warranted (Table IV).

In this group, as in the preceding one, if it is desired to use a piece of tube or catheter to serve temporarily as a splint for healing and a channel for transmission of bile, experience seems to indicate that a T-tube is best. On three occasions I have had to remove tubes which had been left in the common duct. In 1 case this was required following choledocholithotomy performed elsewhere; in each of the 2 other cases a catheter extended from the duct through the ampulla of Vater into the duodenum and jejunum, and in spite of the fact that three-fourths of its length was in the intestine, intestinal peristalsis failed to detach the catheter from the bile ducts and it had remained in place for several years.

GASTRODUODENAL IMPLANTATION OF EXTERNAL BILIARY FISTULAS

When stricture is complete and involves the common and hepatic ducts, establishment of an external biliary fistula, which later can be coned out and transplanted into the duodenum, has given very satisfactory results. Last year I reported 5 such cases in which I operated (9), in 3 of which excellent results have been obtained (Tables V and VI). In 1 of these 3 cases 3 years and 9 months have elapsed since the transplantation and in another, 2 years. Both patients are in excellent health (Cases 22 and 23). A transplanted fistula became strictured in a third patient (Case 24) necessitating re-implantation. A fairly good result has followed. If a patient presents himself with an external biliary fistula, having been operated on elsewhere, before transplantation of the fistula is considered, the condi-

TABLE III.—EXCISION OF STRICTURE OR TUMOR AND ANASTOMOSIS OF ENDS OF THE DUCT

Case	Age and sex	Serum bilirubin	Date of operation	Symptoms	Previous operations	Results
16	32 M	3.8	2–7–28	Intermittent jaundice and colic, 2 years	Cholecystectomy (elsewhere), 1924	Excellent.
17	56 F	15.0	12–21–28	Jaundice and itching, 5 months	Cholecystectomy (elsewhere), July, 1929	Excellent; T-tube remained in for several weeks.
18	55 F	11.5	10–11–30	Biliary fistula, 4.5 months postoperative; intermittent jaundice and itching 5 years; chills and fever	Cholecystectomy (elsewhere), 1920; liver enlarged and firm; neurofibroma obstructing common duct removed	Excellent; T-tube remained in for several weeks.

TABLE IV.—PLASTIC OPERATIONS FOR LOCALIZED STRICTURES

Case	Age and sex	Serum bilirubin	Date of operation	Symptoms	Previous operations	Operative findings	Postoperative progress
19	41 F	0.5	8–6–25	Colic 5 months; jaundice	Drainage, gall bladder and stones removed (elsewhere), 1924	Incomplete stricture common duct at cystic duct; gall bladder contracted to small fibrous mass 1.5 cm. in diameter	Dec., 1926 jaundice, slight pain; Sept., 1928 jaundice and pain absent since 1926; occasionally slight jaundice, chills, and fever; 10–7–30 good.
20	39 F	9.0	7–30–25	Colic and jaundice, 2 years	Cholecystectomy (elsewhere), 1919	Stricture 2 cm.; reconstructed over catheter; excision duodenal ulcer	Jaundice recurred, 1928; excellent last 3 months, 1929; catheter removed at jejunotomy, 1930; intermittent chills and fever, 3–5–31.
21	38 F	1.4	4–6–29	Biliary colic, 2 weeks; questionable jaundice	Gall-bladder operation (elsewhere), Nov., 1926	Incomplete stricture at juncture of common and cystic ducts	T-tube removed 7–8–29; condition good; 6–28–30 operation successful.

tion of the common and hepatic bile ducts, and of the gall bladder, should it remain, must be ascertained. For example, if material resembling white of egg is excreted, the probabilities are that the gall bladder remains and that there is a stone in the cystic duct. When bile is excreted, the probabilities are that the obstruction is in the common bile duct and that it is caused by stone, by stricture, or by tumor in the head of the pancreas. If transplantation of an external biliary fistula is deemed the procedure of choice, it must adequately drain the intrahepatic ducts, and these ducts must be free of stones; otherwise the obstruction will recur. Furthermore, the possibility of a more certainly curative type of operative procedure, namely, hepaticoduodenostomy, should be considered if sufficient normal duct remains above the stricture or the fistula to enable the duct and the duodenum to be accurately anastomosed.

In May, 1930, I operated on a patient (Case 3) who had undergone cholecystectomy elsewhere in November, 1929, for relief of gall-bladder colic, which had been present for 21 years. Subsequent to the cholecystectomy a biliary fistula had developed. When the fistula closed, jaundice and fever would occur and would continue until the fistulous tract again opened and bile was discharged. At operation, the fistula was found to terminate exterior to a stump of common duct, which was dilated and was 1.5 centimeters in length and 1.5 centimeters in width. The large size of the common duct above the stricture made transplantation of the distal end of the fistula into the duodenum the advisable procedure; this was not done, however, until three stones, the largest 1 centimeter in width, had been removed from the intrahepatic ducts. Had the stones been overlooked they might not have been discharged spontaneously through the anastomosis and symptoms of obstruction might have recurred, thus discrediting the type of anastomosis used. The patient has been in excellent health and without any further evidences of biliary obstruction since his operation.

RESECTIONS OF THE AMPULLA OF VATER

The cardinal symptoms of lesions of the ampulla of Vater are icterus, distention of the gall bladder, and chronic obstipation. Mueller called attention to the fact that probably the most common region of origin of the ampullary growth is the duodenal mucosa at the papilla, where an ulcer may develop, and that jaundice, the main symptom, is present except in a few cases in which ulceration of the lesion permits a channel to form through it for the passage of the bile. Such a lesion

TABLE V.—TRANSPLANTATION OF EXTERNAL BILIARY FISTULAS

Case	Age and sex	Serum bilirubin	Symptoms	Date	Operation	Postoperative progress
22	43 F	15.0 0.3	Pruritus and jaundice, 1 month	1927 12–8–27 3–13–28	Cholecystectomy (elsewhere) Establishment external biliary fistula Transplantation external biliary fistula	Excellent, 1928; abdominal pain but condition good, 1929; excellent, 1931.
23	59 M	9.4	Jaundice and colic, 1 year; drainage of bile	1928 June, 1929 12–28–29	Gall bladder and stone in common bile duct removed Stone removed (elsewhere) Transplantation of external biliary fistula	Good, 1930; excellent, 1931.
24	33 F	16.0 9.4	Jaundice, 1 month; itching and nosebleeds; putty stools; chills	2–3–30 3–11–30* 5–8–30 12–26–30 3–17–31	Cholecystectomy (elsewhere) Establishment of external biliary fistula Transplantation of external biliary fistula into stomach Establishment of external biliary fistula Transplantation of external biliary fistula into stomach	Excellent until Dec., 1930, then recurrence jaundice; 9–10–31 general condition good; occasionally chills and fever; liver function and retention of dye, graded 3; serum bilirubin 4.7.
25	43 F	2.7	Jaundice, 10 months	1928 12–19–28 3–7–29	Cholecystectomy (elsewhere) Establishment of external biliary fistula Transplantation of external biliary fistula	Excellent 4–3–29; biliary colics and jaundice on 12–2–29; 11–27–31 frequent pain, jaundice, chills, and fever; general condition not good.

*Operative findings; adhesions of common duct and pancreas; enlargement of liver; stricture of common duct and biliary cirrhosis.

may cause erosion of a blood vessel, producing intestinal hæmorrhage and marked secondary anæmia.

Such a history of intestinal bleeding, with marked secondary anæmia, was the only symptom of the patient whose ampulla of Vater including a portion of the duodenum, I successfully resected, performing choledochoduodenostomy at the same time. At operation, July 23, 1931, a distended gall bladder and common bile duct, the walls of which were normal in color and in which no stones were palpated, directed attention to the pancreatic and the ampullary portion of the duct. The head of the pancreas was normal to palpation but there was apparent thickening or enlargement in the region of the ampulla. The possibility of a benign ulcer of the posterior wall of the duodenum, of a tumor of the small intestine, or of an ulcer or tumor in the end of a Meckel's diverticulum was eliminated by the exploratory operation. The liver was not cirrhotic, and the possibility of bleeding œsophageal varices was eliminated. The details of the operative procedure and a pathological description of the resected lesion are being published elsewhere (10). The ease with which the posterior wall of the duodenum could be brought up for resection after an incision is made through the anterior duodenal wall was noteworthy. Resection of the entire thickness of the posterior wall of the duodenum, including the ampulla of Vater, beginning 1 centimeter beyond the periphery of the lesion and carrying the resection to the pancreas was accomplished, and the posterior wall of the duodenum was approximated by interrupted sutures of catgut. No attempt was made to isolate or identify the pancreatic ducts, for it was felt that the pancreatic fluid would seek a channel between the interrupted sutures, which seemingly has proved to be the case. The common bile duct was divided immediately above the duodenum, the distal end doubly ligated with silk, and the proximal end anastomosed to the duodenum with silk.

Interesting patients from the standpoint of permanency of cure following resection of the ampulla of Vater for carcinoma, was one operated on by Koerte, which patient according to Clar remained cured for 17 years, and Kelly and Burnham's patient who was well for 8½ years following resection of the tumor. In a consideration of the various methods of operation for tumor of the ampulla of Vater, it is only fair to give credit to palliative or conservative methods of relieving the obstruction by anastomosis between the biliary and intestinal tracts and to call attention to Abell's interesting case in which radium was applied by a very ingenious method to the ampullary lesion. If the patient is deeply jaundiced, or if his condition is such that resection of the ampulla cannot be accomplished with a reasonable margin of safety, it would seem that the palliative operation of biliary intestinal anastomosis is indicated. On the other hand, if the patient is in good condition and the lesion is producing such symptoms as bleeding which may terminate the patient's life unless the lesion is removed, it would seem that resection should be undertaken. It is evident that cholecystostomy or cholecystgastrostomy are advisable preliminary to resection of the ampullary lesion if patients are deeply jaundiced. In further support of the argument favoring ampullary resection in indicated cases is the relative benignity of carcinomata of the ampulla of Vater.

TABLE VI.—HOSPITAL MORTALITY FOLLOWING OPERATIONS FOR STRICTURE OF THE COMMON AND HEPATIC BILE DUCTS

Case	Age and sex	Serum bilirubin	Date of operation	Symptoms	Previous operations	Operative findings and operation	Postoperative progress
26	36 F	11.1	9-4-28	Painless jaundice, 5 months; coagulation time 11 minutes	Cholecystostomy (elsewhere), 1927; cholecystectomy (elsewhere), 1927	Stump of hepatic duct 3 mm.; inaccurate anastomosis over T-tube (hepaticoduodenostomy)	Transfusion Sept. 4 and 9; died 9-12-28; renal and hepatic insufficiency (clinically); intra-abdominal hæmorrhage (necropsy).
27	48 F	12.8	3-6-26	Biliary fistula, 3 months; chills, fever, and jaundice, 8 months; deep jaundice, 3 weeks; splenomegaly	Cholecystectomy (elsewhere), 1925; attempted relief of stricture of common duct (elsewhere), 1926	Extensive stricture of hepatic ducts (common duct stones removed); plastic hepaticocholedochoduodenostomy	Death 3-13-26; (necropsy) intra-abdominal hæmorrhage; acute suppurative cholangeitis; intrahepatic stones and chronic hepatitis.
28	49 F	10.0	7-25-28	Increasing jaundice, 2 months with intense itching; 32 pounds weight loss	Perforated duodenal ulcer closed (elsewhere), 1927; cholecystectomy (elsewhere), Nov., 1927	Complete stricture of common duct to within 0.5 cm. of liver; (hepaticogastrostomy)	Died 7-26-28; (necropsy) intra-abdominal hæmorrhage.
29	49 F	1.8 5.8 1.8	7-22-27 10-19-28 3-18-29	Following operation in 1922; recurrence of jaundice, chills, and fever	Cholecystectomy, 1922; choledochogastrostomy 7-22-27	Complete stricture extrahepatic ducts; liver Paris green with cirrhosis; transplantation of external biliary fistula	Died 3-23-29 of intra-abdominal hæmorrhage; anastomosis satisfactory (necropsy).

SUMMARY

The results in 30 cases of stricture and tumor of the common and hepatic bile ducts and the ampulla of Vater in which I operated at The Mayo Clinic are reported.

Excellent results have been obtained in many cases in which accurate anastomosis has been made between the remaining portion of the duct and the duodenum or between the severed ends of the duct itself, and in which biliary fistulas have been transplanted into the stomach or duodenum. For such procedures to be successful too much infection must not exist in the hepatic parenchyma in the intrahepatic ducts, or in the remainder of the extrahepatic duct above the stricture.

Failure to obtain lasting good results could almost be predicted at the time of anastomosis, if the liver has a marked cirrhotic appearance, if the stump of the duct is unduly thickened, or if purulent bile or granular stones are present within the hepatic ducts.

The ampulla of Vater and a portion of the duodenum of a patient whose only symptom was intestinal bleeding with anæmia were successfully resected. This directs attention to the fact that such tumors may be removed.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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THE SURGICAL ASPECTS OF SUPRARENAL ABNORMALITIES

AMONG the interesting advances in surgery have been the identification and surgical removal of tumors of the parathyroid bodies and of adenomata of the pancreas. The effect of both these growths is to increase the activity of the structures in which they are situated; tumors of the parathyroid bodies increase the excretion of calcium derived from the skeletal reserves, and those of the pancreas cause overproduction of insulin with hypoglycæmia. Identification and removal of such tumors have restored to normal the metabolic activities of the structure in which the tumors were situated.

Further studies on abnormalities of the other ductless glands would indicate that tumors developing in them give rise to characteristic symptoms. Structurally, the suprarenal glands are composed of two distinct parts, the cortex taking its derivative from the mesoderm of the Wolffian body, and the medulla from the sympathetic nervous system. Tumors arising from the medullary substance are neuroblastomata, ganglioneuromata, and paragangliomata. Neuroblastoma metastasizes early to the liver and lungs in the adult, and to the skull and long bones in children. The ganglioneuroma, benign in type, produces no characteristic clinical symptoms. It is usually found unexpectedly at necropsy. Most important tumors of the medullary portion of the suprarenal gland are paragangliomata, benign in character, characterized clinically by attacks of paroxysmal hypertension. Excellent results over periods of more than six years have resulted following removal of suprarenal paragangliomata by Mayo, Shipley, and Porter.

The most frequently occurring suprarenal tumor is that involving the cortex. Several excellent summaries of reported cases have appeared in the literature. To the signs and symptoms thought to be pathognomonic of such tumors, Gallais has applied the name *Le syndrome génito-surrénal* and Krabbé, that of "adrenal hirsutism." Briefly, the syndrome is accompanied by heterosexual changes, such as virilism, hirsutism, amenorrhœa, and occasionally hyperglycæmia with glycosuria. After removal of this type of suprarenal tumor, the secondary sexual characteristics have reverted essentially to normal, as reported by Colletts and Gordon Holmes.

Clinically and experimentally, Marine and Jaffé have shown that an intimate relationship exists between the suprarenal body and the other ductless glands. Further support to their thesis is the fact that in the past year Cushing has collected a group of fourteen cases, the clinical picture of which has been similar to that in cases of tumor of the suprarenal cortex, and in many of these cases he

has found basophilic adenomata of the pituitary gland to be present; sometimes the tumors were so small that it was necessary to study the pituitary body in serial section in order to demonstrate their presence. Inasmuch as in most such cases examination of the suprarenal gland gives no evidence of tumor, but in the occasional case there is hypertrophy of the cortical portion of the structure it becomes necessary to approach the problem from the other angle, namely, to determine whether or not patients with syndromes suggesting tumors of the suprarenal cortex may not also have adenomata of the pituitary body. It might seem that this adds to the complexity of making a differential diagnosis between the two lesions. Such, however, should not be the case, since in many instances the suprarenal tumor can easily be palpated through the abdominal wall, or gives evidence of its presence by displacement of the kidney; furthermore, in doubtful cases, extraperitoneal exploration of the suprarenal gland can be carried out with ease and comparative safety. Transperitoneal abdominal exploration of the suprarenal glands enables one at the same time to determine the condition of the liver as well as of the ovaries, and particular importance should be attached to the ovaries because of the fact that a particular type of ovarian tumor, called arrhenoblastoma, may be accompanied by symptoms of virilism and hirsutism as reported by Robert Meyer of Germany, and Krock, Taylor, and Wolferman in this country. That such a syndrome is also associated with arrhenoblastoma of the ovary may be explainable by the fact that, embryologically, the ovary takes its origin from the wolffian ridge in common with the suprarenal cortex and testes.

As previously stated, since removal of a cortical tumor of the suprarenal alone has been followed by reversion to normal of secondary sexual characteristics, it would be of great interest to note whether or not the removal of the arrhenoblastomata of the ovary and roentgen treatment of basophilic pituitary adenomata would be followed by similar results.

Even a brief discussion of *Le syndrome génito-surrénal*, as characteristic of tumors of the suprarenal cortex would be incomplete without emphasizing the fact that large tumors of the suprarenal gland may occur without this syndrome being present. This is particularly well illustrated in the case of a young woman, aged 32 years, from whom a hypernephroma of the right suprarenal gland, 12.5 by 10 centimeters in diameter, was removed. Although she had had amenorrhœa for eighteen months and had had recurring weekly attacks of pain in the right upper abdominal quadrant, with chills and fever, virilism, hirsutism, or paroxysmal hypertension was not present. Three months following the removal of the hypernephroma, the patient had gained twenty pounds in weight, had had two normal menstrual periods, and had been completely relieved of the attacks of abdominal pain and fever.

The statement of Rowntree and Ball concerning suprarenal tumors is worthy of quotation: "The complexity of the whole problem is especially striking. In many cases, clinical and pathological data indicate involvement of some particular portion of the suprarenal gland and the diagnosis is definite and clear-cut. In other instances, complexity of the clinical picture would seem to point to involvement of both medulla and cortex."

This statement, I believe, would apply equally well to cases in which tumors of any of the ductless glands has resulted in *Le syndrome génito-surrénal.*

WALTMAN WALTERS.

THE OCCLUSION OF LARGE BRONCHI

THE delay of the development of thoracic surgery was probably due more to the fears and dangers of open pneumothorax than to any other one factor. Satisfactory methods for maintaining adequate respiration in the presence of large openings into the chest have obviated to a large extent this difficulty. Probably the second most important factor that served as a deterrent to the development of thoracic surgery has been the absence of a method by which large bronchi may be occluded with safety. The problem is not a new one as Hippocrates is quoted as giving up in despair in his attempts at causing persistent bronchial fistulæ to heal and advising "letting nature take its course."

Many different kinds of procedures have been tried on animals in an attempt to find a satisfactory method of occluding large bronchi. It has been the experience of most investigators that it is not difficult to maintain closure of a bronchus following a lobectomy but that the bronchial stump usually reopens following a pneumectomy. Bettmann believes that the successful closure of a large bronchus depends upon its being covered by peribronchial tissue and that pneumectomy cannot be performed safely because of the absence of enough tissue to cover the stump. Heuer alone has had a low mortality rate in performing pneumectomies in dogs. Most of the methods which he tried gave good results. These results in which an entire lung was removed were very encouraging but it is to be remembered that the conditions differed from that encountered in the human in that infection was not present and also in that the extremely movable mediastinum of the dog allows shifting of the remaining intrathoracic organs.

The most encouraging results by a method which has probably the largest field of therapeutic application are those that have been obtained recently by Adams and his associates of the Department of Surgery of the University of Chicago. Their experiments were performed on dogs. Adams and Livingstone found that complete stenosis of a bronchus 0.5 inches in diameter was a routine occurrence within 2 weeks following the application of a 35 per cent solution of silver nitrate. A small pledget of cotton attached to a wire rod was saturated with the silver nitrate solution and it was introduced into a bronchus through a bronchoscope where it was allowed to remain for about 10 seconds. Stenosis of the lumen of the bronchus was accomplished by a collapse of its wall and by the filling in of the lumen by the injured elements of the wall and granulations. Subsequently fibrous tissue formation took place. If necrosis of the entire bronchial wall were produced, only the epithelium regenerated. Massive atelectasis was associated with the complete stenosis of the main bronchus of a lobe. The use of 50 and 75 per cent solutions of silver nitrate were sometimes followed by death due to pulmonary hæmorrhage.

Adams and his associates have used this method in treating pathological conditions that were produced experimentally. Persistent bronchial fistulæ were produced in dogs by a method which they describe. Prompt closure of the fistula took place in all experiments in from 8 to 14 days following the application of the silver nitrate.

Adams obtained little success in his attempts to close bronchi draining pyogenic lung abscesses in dogs. The abscesses were produced by the Holman-Cutler technique in 8 dogs. Efforts were made to occlude the bronchus of the affected lobe in four of these. Complete stenosis of the bronchi was obtained

in 2 dogs after cauterization had been performed four and six times, respectively. This occurred 3 and 4 months after embolization, by which time the abscesses had healed with cessation of drainage through the bronchi. He concludes that pyogenic abscess cavities healed more slowly when stenosis was attempted than when it was not attempted. On the contrary, when abscesses were produced by emboli containing human tubercle bacilli, it was found that healing usually took place more rapidly in the animals in which the bronchus of the diseased lobe was cauterized.

Probably the most significant results were obtained by Adams and Vorwald in additional experiments in which widespread pulmonary tuberculosis was produced in dogs by the introduction of human tubercle bacilli into the blood stream. A saline suspension of human tubercle bacilli was injected into the femoral vein. Two to 6 weeks later massive atelectasis of two of the lobes of the lungs of each dog was produced. The animals which had not died by the end of 4 months were sacrificed. Few or no tubercles were found in the atelectatic lobes, whereas the inflated lobes were studded with miliary tubercles. Microscopic examination revealed an occasional small tubercle in the collapsed tissue, while in the inflated lung were many large tubercles with caseating centers. In other experiments, tubercle bacilli were injected into the left pulmonary artery. The left primary bronchus received an application of silver nitrate 2 to 6 weeks later. At autopsy, varying amounts of tuberculosis were found in the inflated right lung while the atelectatic left lung showed no gross involvement.

As to whether or not the brilliant results that were obtained by Adams and his associates in their experimental work can be duplicated in patients, it is too early to state. The method probably will not be effective in pyogenic infections unless there is an associated fistula to the exterior which allows adequate drainage. One would not, I think, expect to be able to close by silver nitrate a bronchus communicating with a large tuberculous cavity that was associated with a productive cough. Even though such a bronchus could be closed, it might prove unwise to do so. It would seem that one should be able to close by this method the bronchus to a lobe in which the non-productive type of tuberculous lesion is present. As a preliminary to lobectomy for tumors, it should lower greatly the mortality rate if satisfactory occlusion of the bronchus can be produced. The very least that can be said for this simple method that may be far reaching in its therapeutic application is that it supplies an additional means by which many problems connected with the surgery and physiology of the lungs may be attacked experimentally. ALFRED BLALOCK.

MASTER SURGEONS OF AMERICA

LEVI COOPER LANE

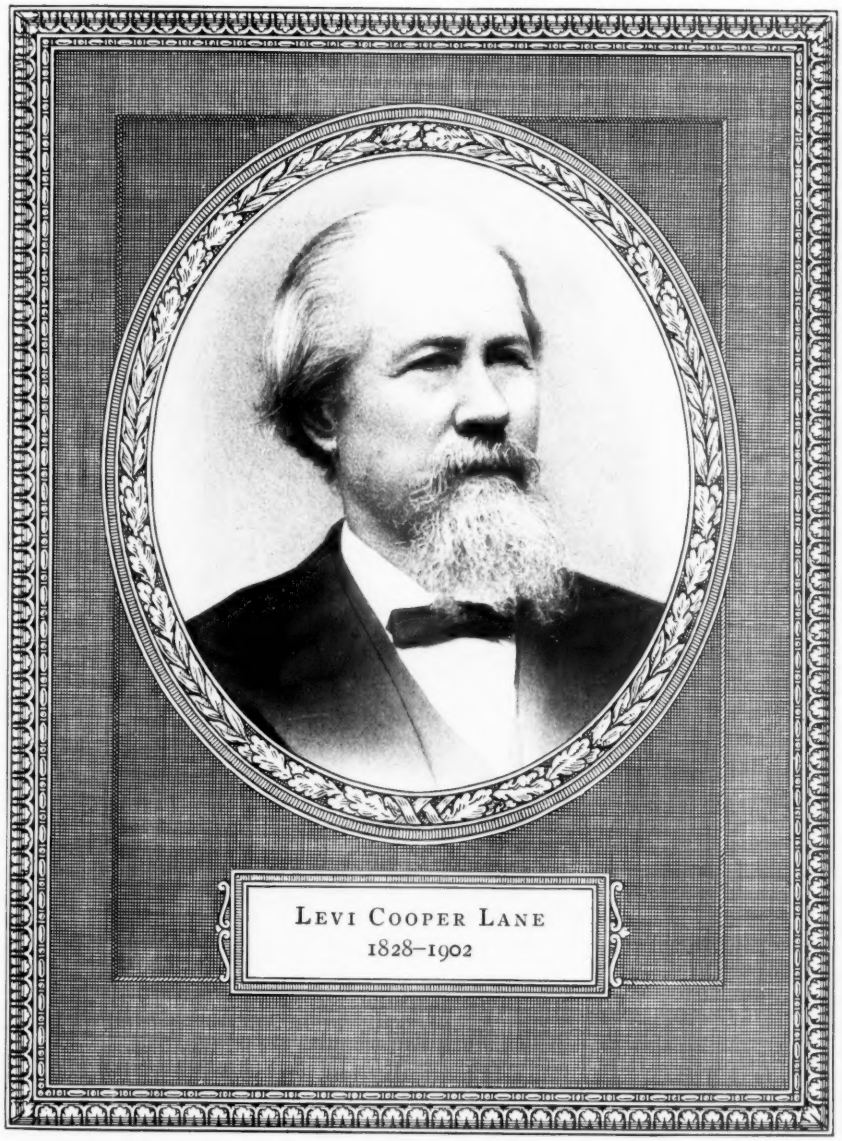
SURGEON, founder of Cooper Medical College, now the Medical Department of Stanford University, builder of the college buildings and Lane hospital; founder of the Lane Popular Lectures (1881), the Lane Medical Lectures (1896) and the Lane Medical Library—this was Levi Cooper Lane.

Dr. Lane was a man of strong character activated by a single purpose, namely, to advance to the limit of his capacity the cause of scientific medicine. To this end he devoted his life with a persistence which, against the handicap of delicate health, knew no check but rose above any discouragement.

Of pure English (Quaker) stock, the oldest of nine children of Ira Lane and Hannah Cooper, Levi Cooper Lane was born on a farm at West Elkton near Somerville, Ohio, May 9, 1828.[1] His paternal grandparents came from North Carolina and his maternal from South Carolina, crossing the Cumberland Gap in 1807. He had some preliminary education at Farmers' College, took his academic course at the Union Theological Seminary, Schenectady, New York, which institution later granted him the degree of Master of Arts and in 1887 that of Doctor of Laws. In 1851 he was graduated from Jefferson Medical College, Philadelphia.

He spent the following four years as interne and house officer at Ward's Island, New York, and in 1855 passed examination for entrance into the Medical Corps of the United States Navy, receiving the highest mark of a class of one hundred, a mark which remained the highest in navy examinations for nearly fifty years. In the great Naval Hospital at Quarantine, Staten Island, New York (3000 beds), he learned to know typhoid fever. He knew it only too well, for he contracted the disease and was desperately ill. He used to say: "These young men have to use a thermometer to make the diagnosis of typhoid fever. They do not know typhoid." His sea duty was on the U.S.S. Decatur and while his ship was in European waters he spent two months in study in Goettingen on furlough. He spent two years on the coast of Central America where he learned Spanish; and in 1858 at Chinandagua, Guatemala, he performed his first operation for goiter. It is of some interest to note that his vessel was the refuge of some of Filibuster Walker's men.

[1]Due to discrepancies in family records the date of Dr. Lane's birth has been variously given as 1828 and 1830, but the former is the date understood by Dr. Lane himself and recorded by him.



LEVI COOPER LANE
1828–1902

UNIV. OF MICH.

Dr. Lane resigned from the navy in 1859, and at the invitation of his uncle, Elias Samuel Cooper, who founded the first medical college on the Pacific coast (1858), joined him in the practice of surgery in San Francisco and entered the faculty of the medical school as professor of physiology.

After Cooper's death in 1862, the school languished; and when in 1864 Dr. Hugh H. Toland founded the Toland Medical College (now the medical department of the University of California), erecting a commodious building, Lane with several other members of the old faculty became teachers in that institution. In 1870, Dr. Lane resigned from Toland College and reorganized the old school.

Two years (1874–1876) Dr. Lane spent in Europe in intensive study. He attended a course in pathology by Virchow and in London received the degree of "M.R.C.S."

In 1881 Dr. Lane, without so much as consulting his faculty, built a great college building and invited the faculty of the medical college of the Pacific, as the old school was called, to join him in developing a new school to be known as Cooper Medical College, in honor of his uncle.

It is interesting to note that the gift of the building was on condition that there be given by the faculty each winter a course of popular medical lectures. This course of lectures has been given annually ever since, the fiftieth course being completed this year. In this matter of the instruction of the general public in medical science Dr. Lane was at least thirty years ahead of his time.

In 1890 Dr. Lane built an addition to the College building, doubling its size and in 1894 built Lane Hospital (250 beds). He was proud to state that he had built these buildings "with moneys earned by himself in his profession."

Among the most far reaching of Dr. Lane's accomplishments was the founding of the Lane Medical Lectures, for students and practitioners. The happy choice of William Macewen, regius professor of surgery, University of Glasgow, to inaugurate the course, gave the lectures such prestige that there has never been any difficulty in securing as lecturers men of the highest attainment in medicine, surgery, and medical research, such as Sir Michael Foster, Sir Thomas Clifford Allbutt, William H. Welch, and Sir Patrick Manson.

Dr. Lane died February 18, 1902. By the will of his widow, whose death occurred the following August, one-third of his estate was given to Cooper Medical College, all that could be given by the then law of the State of California, for the purposes of a medical library. This library, since known as the Lane Medical Library, is the largest and most complete west of Chicago, and ranks perhaps fifth in importance in the United States. It is not merely a College library but is administered for the benefit of the medical profession.

Though never robust physically, Dr. Lane, by virtue of self discipline and perseverance, conducted an enormous medical and surgical practice. All his life he was a student. He early learned to divide his sleep, working at his books the

larger part of every night. Six nights in the week he read medicine, the seventh general literature. He read easily Greek, Latin, French, German, Italian, and Spanish. As an exercise in Greek he religiously read Hippocrates once a year.

He wrote comparatively little; his thesis on "External Urethrotomy" and one or two other papers were in Latin; in addition these were a few medical papers, e.g., on supracondyloid fracture of the elbow, read before the American Surgical Association, 1895, a few pamphlets, mostly controversial, for he lived in a period when personalities were prominent. In the matter of the supracondyloid fracture of the elbow, he insisted upon the "straight position," molding the joint daily by passive flexion. He secured excellent results, doubtless more because of the molding of the soft callus than the position of retention. But he was wont to classify surgeons as good or not according to whether they treated fracture of the elbow in the straight position or otherwise.

He translated Billroth's *Surgical Pathology* for his students, laboriously writing out the translation in blank books and finishing this or that chapter, as seen by his notes, at three or four in the morning. He projected a great textbook on surgery in three volumes, but lived only to complete the first, *Surgery of the Head and Neck*, which, though perhaps ill timed, nevertheless is a mine of personal observation, rich in reference to the surgery of the nineteenth century.

A skillful anatomist, he maintained for many years a small private dissecting room where he was wont to prepare himself for any unusual operation by dissecting the part ahead of time.

He was a humanitarian of intense feeling for the unfortunate, and while not interested in the conventional organized charities, did much private charitable work, and no one knows how much. He said: "It is a great thing to relieve pain." A keen observer of human character, he had no patience with a shirk or a malingerer, and his incisive tongue and classical vocabulary left no misunderstanding as to the duty of the individual to society, but on the other hand he often said he wished no man to feel too poor to have his services. I heard him say that any man who had been in Andersonville or Libby prison could have his services without charge.

If one were to seek a single word to indicate the dominant feature of his character it would be loyalty, for his friend could do no wrong and his enemy no right. How penetrating the glance of his keen blue eyes as he sought loyalty in others!

As a surgeon his methods were not brilliant, but simple and direct. He was not greatly original and yet at the instance of a mother whose child was afflicted with microcephalus, who asked him could he not unlock her baby's brain and give it a chance to expand, he performed a craniotomy similar to that done by Lannelongue many years later. Vaginal hysterectomy he worked out as an original anatomical problem before 1880 not being aware that the operation had been

done in France in the early years of the nineteenth century and had been forgotten. He was a pioneer in suprapubic prostatectomy and devised a long pair of scissors with suitable curve for cutting away the middle and lateral lobes of the gland, guided by a finger in the bladder. He did much work on goiter and was very successful. His method in pre-antiseptic days was to shell out encapsulated adenomata and in diffuse goiter to transfix the gland with a peculiarly shaped transfixing forceps of his own design, cutting the tissue between ligatures, therefore, with little bleeding. He called thyroidectomy the operation of a hundred ligatures. He used silk for ligatures, and left the ends hanging out of the wound for drainage to be drawn out as they became loosened. He performed many notable operations, having the courage to attack the most desperate cases. On one occasion, while operating for extensive cancer of the mouth, he was obliged to ligate the common carotid and in a few hours ligated the other, practically simultaneous ligation of both common carotids. The man lived for a number of years, a monument perhaps more to the size of his vertebral arteries than to the prowess of his surgeon. He ligated the abdominal aorta for aneurysm but never published the case. The man lived four or five days, when, pulling himself up into a sitting position, he strained and tore open the artery.

Towards the end of his career he was afflicted with a slowly progressive disease, purulent bronchitis, and some said he suffered from diabetes. He was engaged in writing the second volume of his textbook on surgery, *Surgery of the Chest and Abdomen*, struggling to complete it. At first he wrote twenty pages in a night, then fifteen, and then ten, and as his weakness progressed the pages gradually diminished to three, but he wrote these three, then two and finally one daily before he was obliged to give up.

He had no children, but Cooper Medical College was to him a child. Feeling that the institution had been built up by the devotion and self sacrifice of himself and faculty (surely the young men who succeeded him could carry on with similiar devotion), he had inserted into the deeds of the property to the corporation clauses to the effect that should the directors at any time cause the college to be united with any other institution, the property should automatically revert to the state. However, shortly before his death it was gradually borne in upon him that the cost of medical education was increasing by leaps and bounds, that substantial salaries had to be paid to the non-practicing members of the faculty, the physiologist, the anatomist, the pathologist, the chemist, and the bacteriologist, and costly laboratories must supplant the lecture room. There was in sight no adequate endowment. Therefore, realizing that the institution could not stand alone and remain a class A medical school, he had the entire property deeded back to him by the corporation, whereupon he redeeded it to the college with the restrictive clauses omitted. He went further and entered into negotiations with David Starr Jordan, president of Stanford University, looking toward the ab-

sorption of the school in that University. The amalgamation took place in 1909, seven years after Dr. Lane's death. The conditions on which the directors of the college deeded the College property to Stanford University were simply that the property should be used for purposes of medical education in the sense of teaching young men and young women to be practitioners of medicine and that Dr. Lane's memory should be suitably preserved. Since buildings become out of date and have to be replaced, Dr. Lane's real monument is the Lane Medical Library and the Lane course of Medical Lectures, more enduring than brick or stone.

EMMET RIXFORD.

EARLY AMERICAN MEDICAL SCHOOLS

THE MEDICAL COLLEGE OF VIRGINIA

WYNDHAM B. BLANTON, M.D., RICHMOND, VIRGINIA

THE third medical school to be established in Virginia was organized in Richmond in 1838 as the Medical Department of Hampden-Sidney College. It began as a private venture inaugurated by a group of young men, several of whom had previously taught in other institutions. It was hoped that the new institution would attract some of the 400 and more students who were every year leaving Virginia for study in Northern medical schools. The founders were an exceptional group of men. Augustus L. Warner (–1847), graduate of the University of Maryland and fresh from the chair of anatomy and surgery in the University of Virginia, became dean and professor of surgery and surgical anatomy. He possessed marked ability as an administrator and surgeon and was the moving spirit in the new enterprise. John Cullen (1797–1849), native of Ireland and graduate of the University of Pennsylvania, was accorded the chair of the theory and practice of medicine, adorning it until his death in 1849. Lewis Webb Chamberlayne (1798–1854), of proud Virginia ancestry, likewise a graduate of the University of Pennsylvania, held the chair of materia medica and therapeutics. Socrates Maupin (1808–1871), "a quiet little gentleman" and a graduate of the Medical Department of the University of Virginia, assumed the chair of chemistry and pharmacy. In 1853 he resigned to accept a similar position in his alma mater where he was shortly honored by being made chairman of the faculty. Richard Lafon Bohannan (–1887), still another graduate of the University of Pennsylvania, was made professor of obstetrics and the diseases of women and children, a position he acceptably filled until his death in 1887. Thomas Johnson became professor of anatomy and physiology. He had enjoyed the advantages of study in France under Laennec and had recently taught anatomy and surgery in the University of Virginia.

The College opened its doors in the old Union Hotel on East Main Street which had been converted into creditable teaching quarters and an infirmary. There was an impressive anatomical museum and excellent chemical apparatus. In a short while plans were under way for a much more elaborate building, and an entirely new structure on Shockoe Hill was soon ready for occupancy. The Egyptian building, as it is still called, was erected on land donated by the city with money loaned by the Legislature from its Literary Fund. The catalogue of 1845 announced that "the magnificent and commodious College Edifice has been completed." Lecture rooms, dissecting hall, infirmary were all under one roof.

The enrollment steadily grew from 46 in 1838 to 80 in 1851. The attendance did not exceed this number until the Civil War, when classes of more than 200 were taught. Ninety per cent of the students were from Virginia. The tickets of each professor were paid for separately, and for many years averaged between 15 and 20 dollars a subject.

The course of instruction was modeled after that of the older Northern schools. It consisted of two sessions of 4 months each, the second a repetition of the first. Graduation was contingent on two terms of study preceded by a year under some reputable physician, or attendance on the summer course, a thesis, an oral examination, and a fee of twenty-five dollars. In the catalogues stress was laid upon the advantages the school had to offer Southern students—unlimited material for anatomical dissection, bedside instruction in an infirmary purposely housed under the same roof as the college, and the opportunity to study diseases peculiar to the South in their native habitat. In fact the type of clinical instruction given, offering as it did, ready access to ward patients and ample opportunity to follow in each case the progress of disease, was loudly proclaimed as superior to the amphitheater method which was then so popular in Philadelphia.

This tranquil course of events was disturbed in 1854 by an unhappy schism arising out of a disagreement as to who had the right to appoint new members to the faculty, the Board of Hampden-Sidney College or the medical faculty itself. The

Fig. 1. Old Union Hotel, Nineteenth and Main Streets, first building occupied by Medical Department of Hampden-Sidney College.

quarrel assumed large proportions and excited a heated pamphlet warfare. It was ultimately settled by the legislature's granting the medical faculty a new and separate charter. Thereafter the school was known as the Medical College of Virginia.

The new freedom was dearly bought, because a large element of the profession of Virginia was from this time on allied against the institution. This element controlled the medical journals of the state and until the Civil War violently attacked the faculty, relentlessly exposing every weakness of the college. Dr. B. R. Wellford, the professor of materia medica and therapeutics, a man of national reputation and unimpeachable character, bore the brunt of the attacks, choosing as he did to become the mouthpiece of the faculty.

In spite of outside interference the institution made progress and some exceptional men were to be found in her faculty during this period. Jeffries Wyman succeeded Thomas Johnson and gave great and lasting impulse to the teaching of anatomy in the school. Under him the anatomical and pathological museum grew apace. Wyman terminated his teaching in Richmond to become Hersey professor of anatomy at Harvard. Meredith Clymer who held the chair of medicine from 1848–1849 subsequently occupied several professorships in the North and achieved distinction in the field of nervous and mental disease. More memorable was the brief occupancy of the chair of the Institutes of Medicine by Charles Edward Brown-Sequard. The famous savant taught in the college for a single session. He filled the basement of the college building with experimental animals, let down into his own stomach sponges on strings, withdrew them before the class to demonstrate digestive fluids in action, and did many another novel and startling thing to the delight and wonder of his class. His passionate love of science and the facility he possessed of compelling nature to reveal her secrets for first-hand observation, made a lasting impression on his students.

The Civil War added immensely to the responsibilities of the college. In the fall of 1859 Dr. Hunter McGuire was successfully conducting an extramural school in Philadelphia. Through his personal influence and effort the Southern students in both the University of Pennsylvania

Fig. 2. Egyptian Building.

and Jefferson were assembled and transferred *en masse* to Richmond. Two hundred and fifty strong, they were met at the station by enthusiastic citizens and students and later welcomed by Governor Wise in an address in the Capitol Square. Many of these students elected to continue their course in the Medical College of Virginia. This trebled the student body and taxed the institution to capacity. The Legislature rallied to the support of the college, voting thirty thousand dollars for a new hospital which was shortly erected adjacent to the college. Throughout the period of the war the faculty taught at fever heat, giving two courses a year. It was the only Southern medical school which never closed its doors during the period of hostilities. Thousands of soldiers were cared for by the faculty and students. Several of the faculty, in addition to their teaching positions, held important posts in the military service of the Confederacy. Charles Bell Gibson, professor of surgery was surgeon-in-chief for the Virginia forces. James B. McCaw, professor of chemistry and pharmacy, was in charge of the Chimborazo Hospital, an institution that cared for more than 75,000 sick and wounded during the war. The graduation of large medical classes twice a year and the entrance of these graduates into the medical service of the Confederacy was no small part of the contribution of the college to the cause of the South.

The college faced the *post bellum* reconstruction bravely. In spite of poverty and a student body reduced at one time to a bare corporal's guard, efforts were steadily made to improve the standards of teaching and to give the students access to better clinical material. Clinical instruction was offered in Howard's Grove Hospital—an institution of five hundred beds—the college hospital, the Richmond Almshouse, and the City Dispensary.

The faculty after the war was composed of R. T. Coleman in the chair of obstetrics, D. H. Tucker in medicine, J. S. Wellford in therapeutics, J. B. McCaw in chemistry, A. E. Peticolas in anatomy, and Hunter McGuire in surgery. Naturally many changes were wrought as time went on. In 1881 Hunter McGuire resigned and was succeeded by J. S. D. Cullen, of almost equally illustrious war record. Frank D. Cunningham followed Samuel Logan in anatomy in 1867. E. S. Gaillard, editor of *Gaillard's Medical Journal*, taught pathology from 1867–68. Levin S. Joynes and Otis F. Manson were added to the faculty.

The elevation of standards came slowly—too slowly for the critics of the college. The old charge of a "closed corporation," an institution run for personal advantage, began to appear in the journals. The fees were said to have been cut, scholarships abused, and the two short courses

Fig. 3. McGuire Hall, principal teaching unit, Medical College of Virginia.

for graduation were held to be entirely inadequate in preparation for the practice of medicine.[1] *The Journal of the American Medical Association*, in two withering editorials, charged that the faculty was opposed to the medical examining board and had sanctioned the appearance of their students before a committee of the legislature asking exemption from the state examination. This was convincing evidence to the *Journal* that the work of the college was not what it should be. The Governor of the state took a hand and appointed an entirely new board of trustees. After months of futile effort to obtain control of the college, the matter was settled in the courts in favor of the old board.

In May, 1893, a rival school, the University College of Medicine, was organized in Richmond. At its head was Hunter McGuire, a former professor of surgery in the old school, whose reputation was now at its height. About him a large faculty was gathered to teach medicine, dentistry, and pharmacy as the three departments of the new school. From the first this school attracted a large attendance. The enrollment the second year was 180. A graded course was offered in all departments and in medicine extended over 3 years. The institution first occupied the former residence of Alexander H. Stephens, vice-president of the Confederacy. In a few years it was in possession of a new building of its own. A disastrous fire in 1910 produced a desperate situation from which the institution was rescued by the munificent contribution of $100,000 from the citizens of Richmond toward the erection of another new building. The Virginia Hospital with 125 beds, a training school and "a large corps of trained nurses" was close by and under the entire control of the faculty.

The presence of the new school was an admirable stimulus to better medical teaching in Richmond. The old college began at once to look to its laurels. The faculty was enlarged and George Ben Johnston, who at this time became professor of surgery asserting his natural gift of leadership, assumed much the same rôle in the old school that Dr. McGuire did in the new. From now on it was a battle between these superior men and their respective faculties. The old school began by reorganizing its hospital which after 1895 was known as the Old Dominion Hospital. A school of nursing was instituted by Miss Sadie Heath Cabaniss, a graduate of Johns Hopkins Hospital under Miss Isabel Hampton. Under her high ideals and strict discipline it became a school to be proud of. The medical curriculum was expanded and lengthened until in 1894 it became a 3 year graded course of instruction; and in 1897, in imitation of its rival, it was subdivided into the three departments of medicine, dentistry, and pharmacy. In 1899 the 4 year course was adopted. To its surprise the presence of a competitor instead

[1] It is fair to say that students on admission were required to have studied under an approved preceptor for 1 year, and that in addition to the two short terms an excellent summer course was offered by the faculty.

of reducing its enrollment increased it, so that by 1895 its students numbered 139. The intense rivalry of the two institutions created two bitter factions in the medical profession of Richmond, but it put nearly every physician to studying and teaching medicine and accomplished what the old school alone had not been able to do—it stemmed the tide of Virginia students seeking a medical education in Northern institutions. In a single year Virginia medical students in Virginia institutions increased from 225 to 450.

Such a situation in a city as small as Richmond could not always endure. It became more and more difficult to find money to support both schools, for both had radically reduced tuitions—in the case of the old school to sixty-five dollars a year. Leaders wearied of the incessant struggle and longed to exert their united strength in the general cause of medical education. In 1913, old differences were forgotten. The boards of the two institutions met in joint session, amalgamated the two schools and selected a new faculty. Since that time, the Medical College of Virginia, as the consolidated schools were called, has continued to expand and prosper. Now strictly a state institution, which is open to both men and women, controlling four hospitals, with full time professors in all important departments, the college is annually giving instruction to more than eight hundred students.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IN their monograph[1] Sicard and Forestier present a comprehensive work on the use of iodized oil in the form of lipiodol in diagnosis and therapy. The greater part of the work is devoted to the application of lipiodol as a diagnostic medium, relatively little being given as to its action as a therapeutic agent.

The book contains full and comprehensive instructions for the use of lipiodol as an adjunct to radiology in the exploration of various body cavities. Many excellent illustrations depict typical lesions as revealed by this diagnostic aid. The indications for the use of lipiodol in the subarachnoid space in the study of medullary compressions are considered in detail by the authors and the adverse criticisms of the method are answered at length.

The authors do not claim that lipiodol is an all around substitute for careful clinical examination or for the already known radiological contrast media but they do claim that it reveals many cavities and tracts that were heretofore not possible to photograph by means of the roentgen ray and that it is therefore an invaluable adjunct to clinical examination in many atypical and obscure cases. There is appended a very complete bibliography, which is classified according to the chapters of the book, the chapters discussing the different regions treated. Because of this arrangement the book has added value as a handy reference volume in its field.

HALE HAVEN.

[1] THE USE OF LIPIODOL IN DIAGNOSIS AND TREATMENT; A CLINICAL AND RADIOLOGICAL SURVEY. By J. A. Sicard and J. Forestier. London: Oxford University Press, 1932.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE DIAGNOSIS AND TREATMENT OF POSTURAL DEFECTS. By Winthrop Morgan Phelps, B.S., M.D., M.A., F.A.C.S., and Robert J. H. Kiphuth. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

THE 1932 YEAR BOOK OF RADIOLOGY. DIAGNOSIS. Edited by Charles A. Waters, M.D. THERAPEUTICS. Edited by Ira I. Kaplan, B.Sc., M.D. Chicago: The Year Book Publishers, Inc., 1932.

MODERN ALCHEMY. By William Albert Noyes and W. Albert Noyes, Jr. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

OXFORD MEDICAL PUBLICATIONS. HINTS TO THE YOUNG PRACTITIONER. By G. Francis Smith, M.R.C.S. (Eng.), L.R.C.P. (Lond.). London: Oxford University Press, 1932.

A SYNOPSIS OF SURGICAL ANATOMY. By Alexander Lee McGregor, M.Ch.(Edin.), F.R.C.S.(Eng.). With a Foreword by Sir Harold J. Stiles, K.B.E., F.R.C.S.(Edin.). New York: William Wood and Company, 1932.

LECTURES ON MIDWIFERY AND INFANT CARE; A NEW ZEALAND COURSE. By T. F. Corkill, M.C., M.D., M.F.C.P. (Ed.). Auckland, Wellington, Christchurch, Dunedin, New Zealand: Coulls Somerville Wilkie Ltd., 1932.

A SHORTER ORTHOPAEDIC SURGERY. By R. Brooke, M.S., F.R.C.S. New York: William Wood and Company, 1932.

CHIRURGIE DU SYMPATHIQUE PELVIEN EN GYNÉCOLOGIE. By Gaston Cotte. Paris: Masson et Cie, 1932.

THE RHYTHM OF STERILITY AND FERTILITY IN WOMEN. By Leo J. Latz, A.B., B.S., M.D. 2d ed. Chicago: Latz Foundation, 1932.

LE RECTUM CANCÉREUX; SON AMPUTATION PAR VOIE ABDOMINO-PÉRINÉALE AVEC ABAISSEMENT DU COLON AU PÉRINÉE. RÉSULTATS POST-OPÉRATOIRES. By Dr. Edouard Regard. Préface du Docteur Robert Soupault. Paris: Les Éditions Véga, 1932.

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LES FRACTURES DES MEMBRES; CLINIQUE ET THÉRAPEUTIQUE. By René Simon. Paris: G. Doin & Cie, 1933.

PAPERS RELATING TO THE PITUITARY BODY, HYPOTHALAMUS AND PARASYMPATHETIC NERVOUS SYSTEM. By Harvey Cushing. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

CHAPTERS IN AMERICAN OBSTETRICS. By Herbert Thoms, M.D. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1933.

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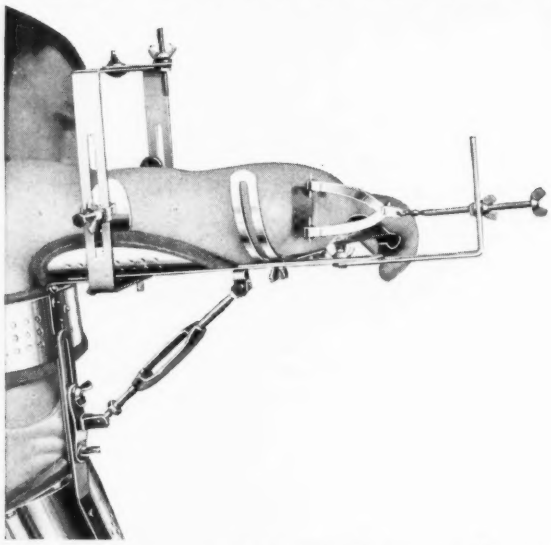

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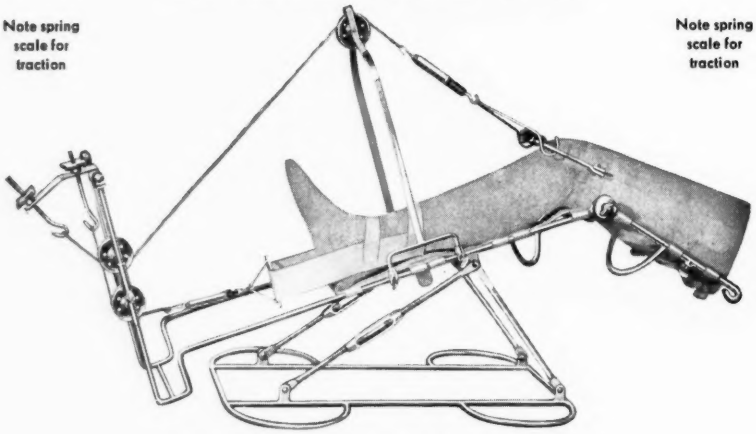

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(Illustration showing splint tilted for bed pan use)

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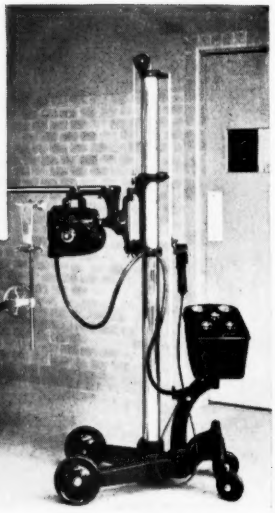

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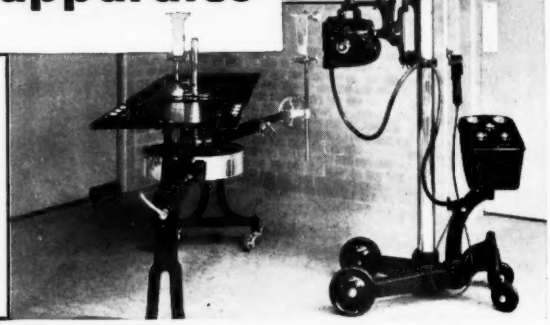

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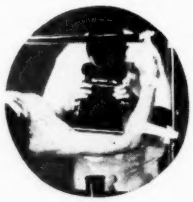

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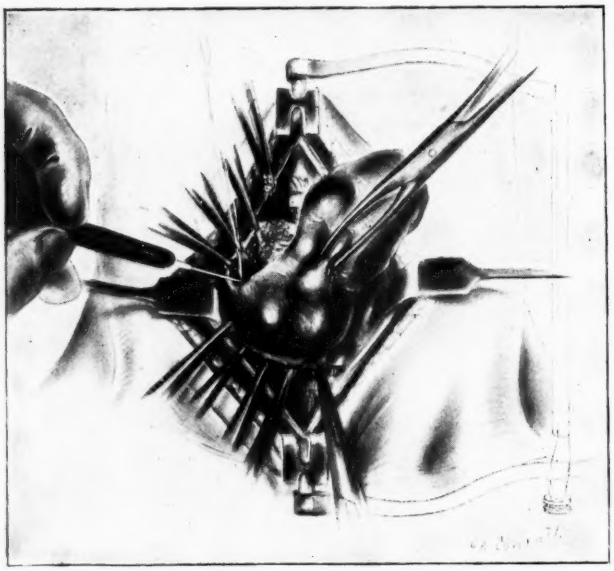

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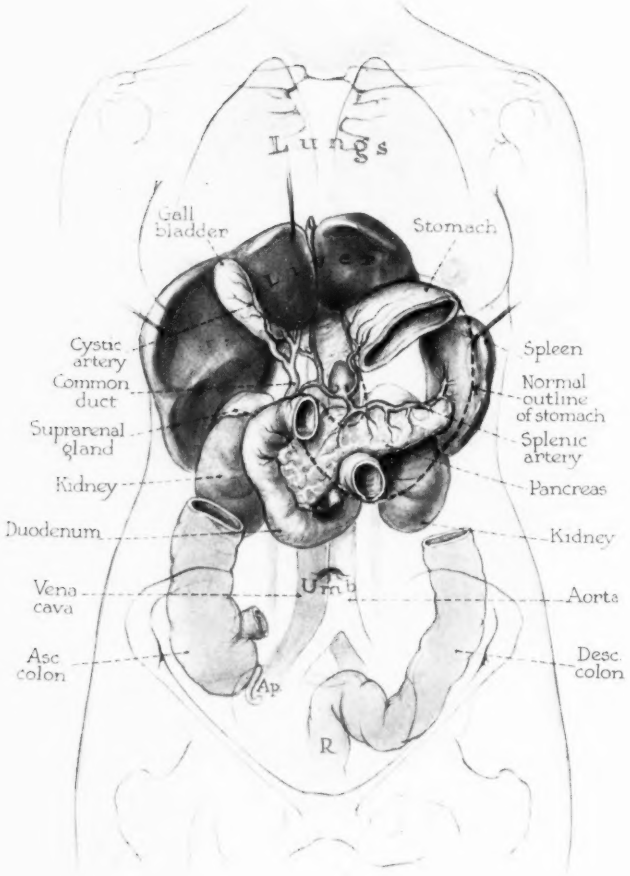

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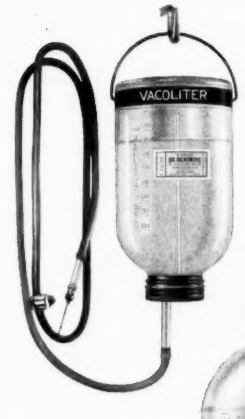

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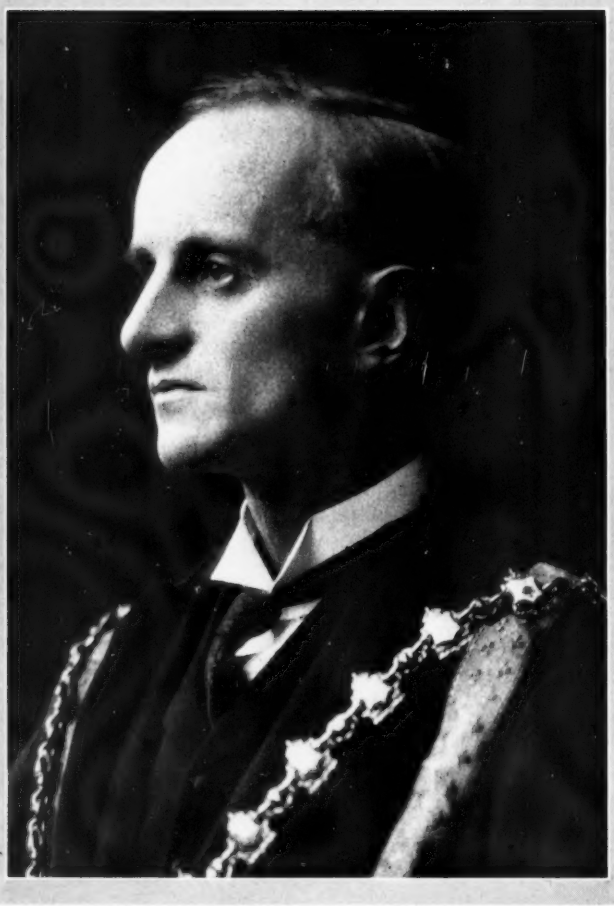

Mayo Thurber.

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PILLARS OF SURGERY[1]

SIR WILLIAM I. DE COURCY WHEELER, DUBLIN, IRELAND

For him the best was hardly good enough,
With good unbettered he could never rest;
His eye could see perfection in the rough,
His aim—a little better than the best!

TO pay homage to the memory of a great surgical benefactor and to focus attention on what he has bequeathed to posterity, is not only a great honor, it is a solemn duty.

Eloquent and impressive tributes to the memory of John B. Murphy have been offered by my predecessors in past years. Tonight, it is my proud privilege, on your invitation, to lay a wreath from Ireland on the tomb of remembrance.

On an occasion such as this, our minds are focused upon an outstanding personality in the center of the stage. Yet we must not miss the procession of kindred spirits which are for the moment in the background. Our perception is blurred by the numbers and by the distance, but many familiar figures appear and disappear as the procession moves on. We recognize Hippocrates as he was in about 400 B.C. We cannot mistake the identity of Celsus for he carries with him his seventh book "De Medicina" in which he describes the attributes of the perfect surgeon.[2] Now we see Galen whose works were accepted for a thousand years. There is a pause and Ambroise Paré stands out alone. In turn come Pott and Hunter and in a group nearby stand Velpeau, Dupuytren, and Malgaigne. Cooper, Syme, and Bigelow are prominent, but watch, and in the radiant light you will see the outstanding figure of Lister surrounded by the leaders of modern times.

Many great American and British surgeons, some bearing Irish names, flit across our gaze; they are standard bearers in this pageantry of notable pioneers.

Murphy was born about Christmas time in the year 1857.

His parents were Michael Murphy and Ann Grimes. They came from Limerick, Ireland, and were married in America, about 1849, when they settled on a farm near Appleton, Wisconsin. There were six children: Daniel H., who became a priest in the Roman Catholic Church; Michael P., a farmer; Ellen, who married a railroad conductor; Lou, who became a Nun; John Benjamin; and Frank, who was a druggist in Chicago.

At the time Murphy commenced his meteoric climb, surgery was a tangled mass of obscurities, the result of a compromise between ancient and modern methods. He discarded the remnants of time-worn beliefs, and set out to explore with vigor the productivity of virgin soil. The ground was cleared in face of many obstacles until at last it was open for the approach of those who were to follow in his trail.

[2]A surgeon ought to be a young man or at least comparatively young with a hand that is strong, steady, and never trembles. He should be equally ready with his right and left hand, quick sighted and clear sighted, fearless, pitiless, so that he is determined that his patient shall be cured, and he himself, unaffected by the shouting cries of his patient, may not be too hasty nor cut less than is necessary. He is always to act as if the patient never uttered a wail of pain.

[1]The John B. Murphy Oration in Surgery, presented before the Clinical Congress of the American College of Surgeons, St. Louis, October 17-21, 1932.

In previous Murphy Orations the career of this great surgeon has been traced step by step. He was a man of destiny, singled out when young to climb the heights of fame. In his youth, he realized that the pinnacle could be reached only with the helping hand of those who had climbed before. He put a high value on the advantages of travel, and thus in the year 1883 he came under the influence of Billroth, of Vienna. He spent 18 months in Europe and returned to America at a time when the lines of scientific advance were veering round from the old world to the new. In these early days he could not have foreseen what a part he was to play in accelerating the rapid progression of American surgery.

Lord Moynihan stated in the first Oration (1920) that Murphy was beyond question the greatest clinical teacher of his time. He assuredly had no rival. His statements were dogmatic, and were accepted as decisive without reserve, unless by a dissentient few. His success as a teacher may be attributed in large measure to one outstanding fact—what he preached was reinforced and supported by detailed and logical reasoning, the outcome of deep investigation and of original thought. Glance through his writings and it will be found that all his emphatic dicta are followed by explanations, which to the minds of his readers, put their accuracy beyond the possibility of doubt. Not infrequently, on the other hand, at a lecture, he would bring his listeners into the realm of speculation. He made them think. He weighed one argument against another. When conclusions were premature he advised caution. He avoided giving judgment on matters which were still *sub judice;* he waited until there was proof of the rights and of the wrongs.

When teaching clinical surgery in Dublin, I have read beforehand Murphy's articles on the subject under review. With this preparation I could hold the attention of the class. The modern student appreciates in teaching what may be called the straight deal. He resents ambiguity presented in a juggle of many syllabled words and in a confusion of thought. He does not attend hospital for a repetition of the average lecture or textbook platitudes. Teaching with an eye on the clock for approaching examinations is irksome to all. It is labored and artificial, and as often as not quite antiquated and useless. These facts are emphasized between the lines of every article which Murphy wrote. What could be better than his description of the phenomena which attend the onset of metastatic arthritis? His pen picture of the exact time when each particular organism reached the joint, and the reaction of the various structures concerned in this invasion, has never been surpassed. His work on arthroplasty is monumental.

Little has been added, by modern investigation, to Murphy's ideas on the protective and defensive powers of the peritoneum in early septic conditions, as contrasted with the offensive and destructive powers of the infection in neglected cases.

He developed the treatment of pulmonary tuberculosis by the production of artificial pneumothorax more than 20 years ago, and he was one of the first to stress the significance of back pressure on the kidneys in cases of prostatic enlargement.

His talks about bone grafts include the rôle of the periosteum, the life history of the graft, and finally, he lays emphasis on the salient points in operative technique.

His remarks on the part played by the fallopian tubes in the production of tuberculous peritonitis, and his addresses on such subjects as acute appendicitis in cases of pregnancy, are the acme of clear thinking.

His appropriate observations on physiology and histology when discussing division of the sympathetic, the nerves of special sense, and peripheral nerves, will stand the test of time.

He was proud of his button. But like Lane's bone plates it was but a signpost in the progress of surgery. The pace of this progress was set by Murphy himself and the signposts were soon passed by and lost in oblivion. Nevertheless, Murphy's button and Lane's plates admittedly were the product of gifted minds. They are metallic links of union between the old ideas and the new. They are small but interesting examples of how the chain of surgical progress has been forged. Each link is more polished and better finished than the last, but it is an endless chain.

In the early days of the War I was visiting Sir Robert Jones, of Liverpool, when the Lusitania arrived from New York with John B. Murphy on board. In the afternoon he came to visit Sir Robert, and there I met him for the first time. Jones, the acknowledged master of orthopedic surgery was at work. Many of you know him, and place him as we do, as a superman who has the secret of perpetual youth. The first operation on the list was for the correction of a malunited Pott's fracture; the second was bone grafting for an ununited fracture of the leg. I can still see Murphy keen and intent watching every movement, every detail. The cases he was observing were after his own heart. He had written repeatedly on ununited and malunited fractures in the region of the ankle; in the sphere of bone grafting he was at his best. I waited for him to speak. I expected to hear something of the methods he himself had advocated, but he only gave expression to his unbounded admiration for the operative dexterity of another man. Here was a generous personality, quick to appreciate and quick to acknowledge perfection when he saw it. In plain language, Murphy had the instincts of a great gentleman.

From Liverpool, we traveled together to Leeds. He was communicative and talked freely. It was an experience which I can never forget. He was familiar with, and was interested in, the work of my colleagues in Ireland. He invited me as his guest to Chicago, an invitation which, alas, in War time I was unable to accept.

At Leeds we saw Lord Moynihan perform an intestinal anastomosis. Some pardonable egotism might have been expected from such an onlooker as Murphy, possessed as he was of an unrivaled knowledge in this branch of surgery. Once again with all sincerity he played the part of the appreciative admirer. He whispered to me that he would have traveled all the way from America to be a witness to the operation which he had just seen performed.

Murphy's unstinted recognition of the work of others would alone have secured him a high place in the esteem and affection of the profession in every land.

It would not be a true picture, if Murphy was portrayed as a man surrounded by surgical intellectuals worshipping at the shrine of his clinic in Chicago. If this were so he would rank above human mortals. He had his critics, he had his enemies. There were those to whom Edmund Burke[1] alluded (writing when he was 18 years of age) as "men who look with an envious eye on talents they can never hope to equal, and are willing to bring everything to their own level." Murphy experienced some of this envy and opposition; it is in the nature of things and it can be understood.

It is perhaps a pardonable conceit to couple Murphy's name with those who are associated with the making of the history of Irish medicine. There is a long line of ancestors, but after a cursory glance at the ancients, it will be more profitable to pass over the intervening centuries and concentrate attention on Murphy's immediate predecessors and contemporaries.

Looking back to the year 37 A.D., almost two thousand years ago, we find that the King of Ulster was wounded in the head by a missile and was attended by the great physician Fingen. "Fingen knew from the fumes which rose from a house how many were ill in the house, and every disease which prevailed in the house." This must be true, for it is recorded in the Book of Leinster. The wounded King was stitched with threads of gold "because the colour of his hair was the same as gold." These were the days when Celsus (about 30 A.D.) spoke of sutures, ligatures, and the dressing of wounds.

Almost eighteen hundred years after Fingen, we had in Dublin such figures as Abraham Colles, Dominick Corrigan, and R. J. Graves. Abraham Colles goes down to posterity for his accurate description of the fracture which bears his name. It was published in the *Edinburgh Medical and Surgical Journal* in 1814. He had, of course, none of the advantages of radiography; he never saw the fracture during dissection. And yet, from clinical observation, in fifteen hundred and twenty-eight words, he gave an original and

[1] Early Life Correspondence and Writings of Edmund Burke. By Arthur P. Samuels. Cambridge University Press, 1922.

accurate description of a complex injury. Subsequent investigation found his observations to be almost faultless. This article, together with the accounts of Colles' law and Colles' fascia will be referred to while literature remains.

When studying medicine in Edinburgh, Colles refused to associate with other Irishmen on the ground that "all people make it a rule to fight and quarrel with their own countrymen rather than with any other." In this respect he did his countrymen an injustice. They are not fastidious in the making of such a choice.

Colles was a man of considerable physical strength and determination. On one occasion he walked from London to Edinburgh, a distance of four hundred miles. He earned less than nine pounds the year he started practice in Dublin, but like Murphy, he sprang forward, and he was elected president of the College of Surgeons in 1802 when he was twenty-eight.

In this same year Sir Dominick Corrigan was born. When thirty years of age Corrigan placed his permanent mark on the history of medicine by his description of "Inadequacy of the Aortic Valves." The water hammer pulse and Corrigan's pulse are accepted as synonymous terms. Corrigan had this in common with Murphy—he was the inventor of a button—the two buttons were designed for very different purposes; Corrigan's button was used to fire all and sundry at a time when counterirritation was the order of the day. Sometimes it is used in Dublin even now as an alternative to diathermy, and I have seen gratifying results.

The immortal Graves was five years the senior of Corrigan, and still more distinguished as a clinical physician in the eyes of those most competent to judge. But as a practitioner Graves did not find the same favor in the public eye. The story is told how, when a passenger on board a brig bound from Genoa to Sicily in mountainous seas, he smashed a boat with an axe to prevent the abandonment of the ship by a terrified crew. He repaired the leak in the valves of the foundering ship with leather from his boots and took personal charge of the navigation.

I have purposely mentioned the names of two great physicians and I will mention others, for medicine cannot be divorced from surgery. They and their various handmaids are interdependent; without the one the other must totter and fall.

Graves as a mariner reminds us of the lines written by an author not free from bias:

See one physician like a sculler plies
The patient lingers and by inches dies,
But two physicians like a pair of oars
Waft him more swiftly to the Stygian shores.

Within my own memory in Dublin there were some outstanding figures in the surgical profession. They have crossed the river and are waiting on the other bank to answer their names to the roll call of the selected few.

Among them was Richard Butcher, William Wheeler (the writer's father), William Stokes, Henry Swanzy, Edward Bennett, John McArdle, and Edward Taylor.

Butcher was born in 1819; his father was an admiral; one of his brothers was a bishop. His nephews were outstanding politicians in the British House of Commons in recent times. He died in 1891 leaving all his surgical manuscripts and private papers, his library, his instruments and other articles which he prized, as a legacy to my father.

Butcher was surgeon to Mercer's Hospital,[1] to which I have been attached for 28 years. I remember him attending me as a child for a broken arm sustained in a struggle with a nurse for the possession of a toy. The records of his surgical work in this hospital occupy many volumes. His manuscript notes in my possession prove the meticulous care with which each surgical problem was approached. They are a record of indefatigable industry and of profound surgical acumen. Later I will mention some of the cases which recently have been dealt with under the same roof.

He was an honorary fellow of the College of Physicians of Philadelphia. He was a man possessed of some vanity and of great muscular strength. Like Samson, his hair was long and hung in carefully tended curls over his neck and shoulders. His biceps, revealed

[1] The Dublin Hospital in aid of which Handel first played "The Messiah."

to onlookers when he was operating, was the admiration of medical students. A plaster cast of an arm, typifying perfection in development, is to be seen in the anatomical department of Trinity College. Legend has it that it is the arm of Butcher. In America and in the medical schools of Europe he is best known as the inventor of Butcher's saw.

Some follow letters, others follow law,
And some find happiness in War's alarm;
But he upholds the glory of the saw
And wields his weapon with titanic arm.

He kept a book (in my possession) of newspaper cuttings. The complimentary references to himself are diligently underlined.

An Irish newspaper dated December, 1874, relates how two of the finest athletes in Washington were members of the medical profession, "One of them," says the article, "lifts 1,000 pounds with his hands and puts up a dumb-bell of 130 pounds. The other is said to be the strongest man in Washington for his size. He lifts 400 pounds with one hand, and suspends 63 pounds at arm's length on his little finger." Underneath this pasted-in paragraph is written in Butcher's handwriting—"I have done the same and greater feats."

In July, 1838, when 19 years of age, he was studying in London. He conceived the idea of getting over the roofs of the neighboring houses on to the back of the lion which surmounts Northumberland House Gate in the Strand. With the help of a rope he succeeded. "I have placed the picture of Northumberland House in the book," says Butcher, "because I performed a great feat on it."

I have accused Butcher of vanity, but if time were of no consequence, I could from voluminous documents show that this human frailty was entirely overshadowed by a disposition of simplicity intermingled with understanding and remarkable professional skill.

In about the year 1871, two policemen were shot in the streets of Dublin. One was attended by Butcher in Mercer's Hospital and recovered. The other, a man called Talbot, was operated upon by Stokes and died. The two results were contrasted in newspaper articles. It was publicly suggested that Talbot was not killed by the bullet but had succumbed to indifferent surgery. "We defy you, my lords and gentlemen of the jury," says one paper, "in presence of facts so emphatic, and a contrast so instructive, to declare otherwise than that Talbot did not die of the bullet but of the probe, knife, and forceps." The prisoner in the dock was acquitted.

Apparently there was no control over newspaper comments in those days. The medical student and his friends, did not heal matters, by the publication of verses of which the following are a couple if lines: "Who killed Talbot?" "I," said Bill Stokes, "with me prods and me pokes, I killed him—all but." Stokes was unfairly treated by the press and by the public in this matter. He was a surgeon of high repute, a fine speaker, and by his writings added his share to the knowledge of the day.

Stokes, the great Dublin physician, was the father of the surgeon to whom reference has just been made. A life-long friend of Graves, he became famous in Dublin and abroad for his contribution on the value of the stethoscope, and his description of what is known as the Stokes-Adams syndrome, and Cheyne-Stokes respiration. John Cheyne's account of this type of respiration was published in the *Dublin Hospital Reports*, 1818. The description was clarified and exemplified by William Stokes in the *Dublin Quarterly Journal* in 1846. Hippocrates described the exact same type of respiration when he was picturing the condition, so often alluded to in modern medicine as the "typhoid state."[1]

Swanzy was an oculist of high international standing. Bennett lectured in surgery in Trinity College; he was probably the greatest authority on the subject of fractures belonging to the old school. Bennett's fracture of the metacarpal bone of the thumb was described in the *Dublin Journal of Medical Science* in 1882, with the same accuracy as Colles described fracture of the radius a generation before. Later, I will mention his discovery in connection with congenital laryngocele.

McArdle (a friend of Murphy's and to whom Murphy alluded when speaking to me of Ireland) has only recently left us. His early writings *inter alia* on the surgery of the stom-

[1] Legacy of Greece. R. W. Livingstone. Oxford Clarendon Press, 1921

ach stamp him as a man in the front rank of his time.

It seems but yesterday since E. H. Taylor was writing his book on operative surgery and applied anatomy. He died in his prime, after serving as president of the College of Surgeons.

Finally, came my own father. He was Butcher's favorite pupil. They were close and intimate friends. He was known by medical students as "the Butcher's boy." In 1883 (the Centenary year) he became president of the College of Surgeons. He died at the age of 55 in 1897. In 1886 he described a case of dilatation of the pharynx cured by pharyngotomy, the first case of its kind on record. I have in my possession the sections of skulls in the region of the temporal bone on which he based an original description of an operation for mastoid and tympanic disease, in 1883. The *American Journal of the Medical Sciences* described the paper as admirable. Recent writers have advocated the adoption of the operation which he designed. In an address entitled "What has Society Gained by the Progress of Modern Surgery?" almost 50 years ago he speaks with familiarity of intussusception, pylorectomy, renal cysts, and aneurysm and of surgery generally as "a far grander and nobler science than was that of former years." He denounced Listerism as it was practised at this time. He ridiculed the carbolic spray and the special layers and the particular preparation of the gauze, but he was an early convert to antiseptic surgery which he claimed was entirely different from Listerism. He said that those who imagined that they could wash the air of germs by means of a spray and keep them from a wound by gauze and protective were living in darkness. Surgical cleanliness, he declared, was the keynote of success. He was an advocate of aseptic surgery before the immortal Lister had seen so far. In these matters he saw eye to eye with Lawson Tait.

Like his great master, Butcher, he was a man of powerful physique. He was champion light-weight boxer as a young man when he served in the army. He married a first cousin of George Bernard Shaw.

In 1882, a land agent was shot in Belmullet, an out of the way village in the West of Ireland, 40 miles from the nearest railway station. The Government at Dublin Castle, under the direction of Mr. Burke, the chief secretary, took responsibility for the shooting of Carter, as proper police protection had been neglected. My father was sent to Belmullet on behalf of the Government, to give surgical assistance to the wounded man. In these old days of primitive trains and outside jaunting cars, each journey took almost a day and a half to complete. Several visits were paid and a leg was amputated in 16 seconds! Political feeling was running high; the surgeon found it necessary to carry a revolver and to be protected by police. He charged his account to the Government at 125 guineas a visit, by previous arrangement. The total bill amounted to £1,147.18.0., including 50 guineas for the operation. The Government repudiated liability and there was an action at law. During the evidence, Butcher swore as an expert that if he had been employed he would have doubled the fees.

In those days there was not the fraternal feeling which rules now between the surgeons of one city and those of another. There was considerable rivalry between the surgeons of London and of Dublin. When reference was made by Counsel for the Crown to the more moderate charges of first class London surgeons, Butcher, full of fight, delighted the Irish Jury by suggesting that such men did not exist. The case was withdrawn after a graceful statement by the attorney general and the fees were paid in full.

In mentioning some of those who did credit to the Irish school of medicine, I have not lost sight of Murphy. It was the environment of the ever progressive America which brought this surgical colossus to the heights he attained. The lesser, but still great achievements of his kinsmen in Ireland, may be attributed in a measure to the fact that the same blood flowed through the veins of all.

In an address by Dr. W. R. Bett, of London, entitled "Clio by the Bedside," dedicated to Sir Humphrey Rolleston "because he liked it," it is pointed out that "the elaborate edifice of modern medicine has not sprung up from the ground like a mushroom in the night. Each generation has put its hand to the task, has toiled and labored to complete its superstruc-

ture. Its bricks represent the years, its floors the centuries.

More bricks and more floors will be added by future Murphys throughout the years and centuries that are to come.

The exploration goes on. The explorers wonder as of old what comes next, and what part they are to play. In their dreams they see Valhalla. The spirits of their surgical forefathers are beckoning them to the land where dreams come true. The work will continue when we have shuffled off this mortal coil.

And only the Master shall praise us and only the Master shall blame,
And no one shall work for money, and no one shall work for fame.
But each for the joy of the working, and each in his separate star
Shall draw the thing as he sees it for the God of Things as they are.

Those who have paid homage to Murphy at these great assemblies in past years have alluded specifically to some branch of his work, and some have recorded their own experiences in surgery in order to emphasize their indebtedness to his teaching.

The scope of Murphy's writings is so wide that each successive speaker has been able to find a path which covers new ground. By referring to individual and detached cases, I will endeavor in some small measure to follow this precedent.

I must confess that it is difficult to obtain the end-results of any large series in Ireland. In the first place, we have a multiplicity of small hospitals in Dublin each completely detached from the other. In the second place, our Gaelic temperament is such that patients consider it is ungenerous to admit of any suffering whatever, when inquiry is made for the purpose of statistics to be published abroad.

Some years ago I wrote to a country practitioner to ascertain the end-results of cases of gastrectomy. I explained to him that the information was needed to compare the results from Dublin, with those of other countries, at an annual meeting of the British Medical Association. His reply, dictated more by patriotism than accuracy, indicated that the patients were well in every respect when last he saw them, but that in some mysterious manner they had disappeared one by one from the district. He added that as the country was disturbed they must have been shot, "or died from other natural causes."

SURGERY OF THE BLOOD VESSELS

Pupils in the Hunterian School shared in the enthusiasm of their teachers, and the surgery of the blood vessels became a favorite subject of research and of practice during the opening years of the last century.[1]

The teaching of John Hunter was carried across the Atlantic by Wright Post to New York, by Physick to Philadelphia, by Gibson to Baltimore, and by Warren to Boston. One surgeon alone—Valentine Mott, ligatured the common carotid forty-three times, the external carotid once, the first part of the subclavian once, and the third part of the subclavian four times. It is no matter of surprise, says D'Arcy Power, that the tradition of the surgery of the blood vessels is stronger in the United States than it is in this country. Professor Rudolph Matas has nobly maintained the tradition at New Orleans by his reparative treatment of aneurism which is based upon experimental surgery in the true Hunterian spirit.

Murphy was at home in the realm of vascular surgery. In the year 1896, he performed the first recorded end-to-end suture of a divided artery. His description of how he approached a false aneurism of the axillary artery by division of the clavicle and ligature of the subclavian artery is a noteworthy contribution to his surgical records.

He paints a dramatic picture of a case of aneurism of the internal carotid artery mistaken for a tonsillar abscess. Listen to him speaking. "First a few clots of blood slowly wriggled their way out, and, a little faster a few more. Then came the rush of the arterial current with the full force of the spurting carotid. The patient, strangling in his own blood struggled widely, and his friend ran away in a panic, an abject deserter. Before Dr. Lee could gain control of the patient the latter had bled to death and the office was like

[1] D'Arcy Power. Selected Writings. Oxford Clarendon Press, 1931, p. 26.

a shambles from the struggle." Then comes the mention of thirteen different forms of treatment for aneurism, and finally the statement that no surgeon should start the active practice of surgery until he has done a considerable amount of experimental work on the arteries and veins of dogs. After complimentary references to the operation of Matas he concludes an interesting discourse with the remarks, "We Americans are little inclined to be Chauvinists. We are pretty apt to take what is good where we find it, and if we owe a great debt to foreign medicine, it is because we have had the breadth of vision and unbiased minds necessary to profit from it."

Ligature of the innominate artery for right subclavian aneurism. In May last I ligatured the innominate artery for aneurism of the subclavian artery involving the first and second stage. The patient was wounded in 1915; pieces of shrapnel were shown by X-rays, scattered in the region of the right shoulder joint, and portion of a bullet could be felt to the right of the suprasternal notch under the insertion of the sternomastoid muscle. The wall of the artery was apparently injured, but the aneurism did not become evident until 1928, 13 years after the wound. It steadily increased in size until the swelling above the clavicle reached the size of a duck's egg. The right recurrent laryngeal nerve was paralyzed. The radial pulse was not affected, the blood pressure was the same on both sides. The X-rays demonstrated some calcification within the sac. The Wassermann reaction was negative.

In some respects this tumor was not typical of aneurism; there was no bruit, expansile pulsation could not be detected; there was no difference in the carotid or radial pulses when compared with those of the other side.

An operation was designed to ligature the subclavian artery behind the scalenus anticus muscle at the commencement of the second stage. The middle portion of the clavicle was turned downward on the chest with its pectoral attachments. The aneurism was laid bare and the bullet was removed. The external and internal jugular veins were found obstructed and distended. The supraclavicular and transversalis colli arteries spread transversely across the upper portion of the tumor. The scalenus anticus muscle had disappeared and the phrenic nerve was not located. It was soon seen that the sac extended to the bifurcation of the innominate artery and that ligature of the subclavian vessel was impossible. It was obvious that without further removal of bone the innominate artery could not be exposed behind the sternoclavicular articulation without the rough handling of the aneurism, which had led to disaster in many recorded cases. With chisel and mallet, the inner end of the clavicle together with the right half of the manubrium sterni (leaving the sternoclavicular joint intact) were separated and retracted upward and to the left. The innominate artery was now visualized in its entire length. The innominate veins were not seen; the pleura caused no embarrassment, the nerves remained hidden.

Two ligatures of No. 2, chromicized catgut were passed around the artery distal to the thyroidea ima branch. They were gradually tightened, care being taken not to cut through the inner coats of the vessel. Pulsation at once ceased in the aneurism and the radial pulse disappeared. Proximal to the ligature each pulsation appeared like a sledge-hammer blow upon the occluded portion. It looked as if the assault could not be resisted. For this reason, an additional single ligature of catgut was placed around the artery near its origin from the aorta. The thyroidea ima was ligatured with fine silk. The divided portions of the sternum and clavicle were replaced in position and held by catgut passed through drill holes. Recovery was uneventful but for some downward displacement of the divided portion of the clavicle.[1] In 3 days the radial pulse reappeared and within a week it was full and synchronous with the pulse on the opposite side.

The experience of this case suggests that ligature of the innominate artery is not a difficult operation provided the old inadequate methods of approach are abandoned. Six weeks after ligature some slight pulsation could be felt in the aneurism, but otherwise the cure appeared complete.

[1]Four months after operation the aneurism had completely disappeared. Very slight pulsation could be felt at the site of the original tumor.

Up to and including the year 1922, according to Ballance, there had been 57 ligatures of the innominate artery, with 19 recoveries.[1]

A case of ligature of the innominate artery was exhibited by Mr. Coppinger of the Mater Hospital, Dublin, at the Section of Surgery of the Royal Academy of Medicine in Ireland, on February 24, 1893. The record states that this was the first successful case of ligature of the innominate artery ever exhibited at any medical society in Europe.

The ideal operation for subclavian aneurism is excision of the sac after proximal and distal ligature. This has been successfully performed by Moynihan,[2] by Halsted,[3] who removed with the aneurism a portion of the subclavio-axillary vein, and also by Braithwaite.[4] The possibility of ligaturing either the first or second portion of the artery is a condition precedent to excision. Both portions were involved in the sac in the case I have just mentioned.

In a volume[5] on the works of Colles by Robert McDonnell, who was president of the Royal College of Surgeons in Ireland in 1877, the operation of tying the subclavian artery is admirably described. Colles attempted more than once to ligature the first stage of the artery, a far more difficult procedure than ligation of the innominate. He thought that ligature of the first stage on the left side was almost an impossibility, but A. K. Henry[6] has shown that this operation is greatly simplified by an approach from behind.

Thoracic aneurism treated by wiring. Some years ago (1928), an ex-soldier was admitted to hospital with an aneurism protruding through the chest wall to the right of the sternum below the clavicle. It appeared on the point of rupture. The heart and aortic arch were shown in the X-ray films to be greatly enlarged. It was thought that rupture might be delayed by consolidation, if a wisp of Colt's wire was introduced. A month later the end of the wisp at the point where the wires are joined, became superficial and later ulcerated through the skin. The junction was nipped with pliers and all the strands of wire were removed from the aneurism. Three months after operation the patient died from gradual leakage into the mediastinum and pleural cavity? No postmortem was obtained.[7]

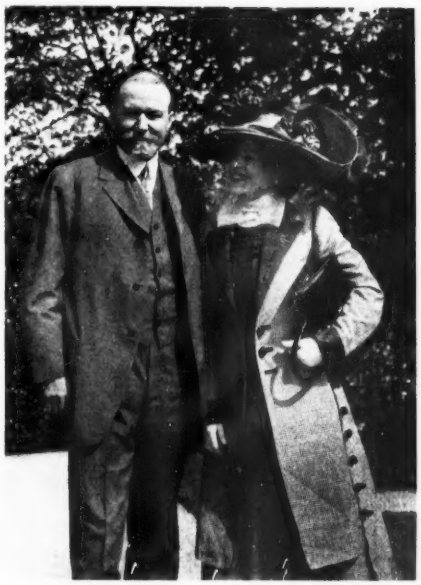

Fig. 1. From a shapshot picture of Dr. John B. Murphy and Mrs. Murphy taken in the garden of Sir Robert Jones, Liverpool, in 1915.

Abdominal aortic aneurism. America holds the world's record for thoracic aneurism treated by wiring and electrolysis. Colt states that Dublin holds the record for abdominal aneurism treated by wiring alone.[8] In August, 1910, a patient with a large abdominal aneurism in the region of the cœliac axis was treated in Mercer's Hospital by the introduction of a cage of Colt's wires (150 inches) into the sac. He died suddenly on March 31, 1928, approximately 18 years after operation. The doctor in attendance reported that there was no abnormality of pulse or temperature or signs of internal hæmorrhage when he saw him just before death, but no postmortem was obtained.

In a second similar case, a wisp of 105 inches of wire was introduced into the sac of

[1] Brit. J. Surg., ix, 438.
[2] Ann. Surg., 1898, xxviii.
[3] Bull. Johns Hopkins Hosp., 1892, July-August.
[4] Brit. J. Surg., vii, p. 90.
[5] London: The New Sydenham Society, 1881.
[6] Brit. J. Surg., x, 367.
[7] These 2 cases are described by kind permission of the Director General Ministry of Pensions.
[8] Brit. J. Surg., xiii, 112.

Fig. 2. R. G. Butcher of Dublin, 1819–1891. President, Royal College of Surgeons of Ireland, 1866–1867. The cartoon bore the inscription: "A wise Saw—'What! Butcher, wouldst thou have thy pound?'"

Fig. 3. Cartoon of Butcher with press references. Note the coat of arms of the cartoonist. "I come, I sawed, I conquered."

the aneurism. After operation, the man was passed as sound for service during the War, as a stoker on a patrol trawler in the Naval Reserve. He died of leakage from a secondary dilatation of the aorta below the aneurism while thus serving, 4 years and 8 months after operation. At postmortem examination the aneurism was found completely consolidated. It was about the size of a full time fetal head. The wires had expanded uniformly. The specimen is preserved in the Surgical Museum of Trinity College.[1]

"I am indebted to Surgeon H. E. King Fretz, R.N., for the following notes on postmortem examination. Case 2.

"The patient, aged 37, a stoker, R.N.R., on one of the patrol trawlers, was admitted into the Naval Hospital on March 12, 1916. He complained of vomiting and severe shooting pain in the right lumbar region simulating renal colic. There was tenderness in the region of the appendix and pain on deep inspiration. He was sweating freely and in a state of collapse. There was a large pulsating tumour which practically occupied the whole of his epigastric region, apparently an aneurism of the abdominal aorta. His temporature was 97° F.; pulse 120, full and regular; systolic pressure 280 mm., diastolic pressure 120 mm. His urine showed a heavy deposit or urates and a trace of albumin. There was an excellent scar to the left of the mid line 3 inches long, the result of operation five years ago. A systolic bruit could be heard over the swelling, propagated all over the abdomen and down both femoral arteries. There was a marked diastolic sound in the mitral area and a very accentuated second sound in the aorta. Seven days after admission he died. The swelling continued to pulsate long after respirations had ceased.

"At the autopsy it was found that there was a small leak, the hæmorrhage penetrated between the layers of the mesentery, separated them widely apart, and surrounded a large portion of the small intestine. The right kidney was pushed forward. Both kidneys and spleen were normal in size, the right kidney having small granular patches on the surface. The heart was much enlarged. 'Now for the aneurism, I am not exaggerating when I say that the clot formed in it is as hard as a rock, the aneurism itself is about the size of a full term fœtus head. It appears to me as if there is a secondary dilatation of the aorta below the main swelling and that is where the trouble arose.'

[1]Lancet, p. 7, 1917.

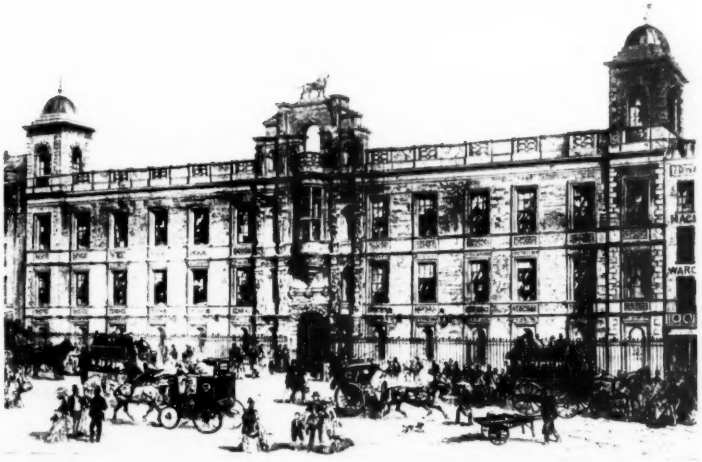

Fig. 4. Northumberland House, Strand, London. Butcher, in July, 1838, describes how under perilous circumstances he succeeded, with the aid of a rope, in climbing on the back of the lion.

"I am also indebted to Surgeon King Fretz for the specimen which is illustrated in Fig. 1, and for the X-ray photograph showing the wire *in situ* (Fig. 2)."

The abdominal aorta was first ligated by Sir Astley Cooper. In 12 cases recorded subsequently, the mortality was 100 per cent. Nevertheless, ligature below the renal vessels has been followed by success. Brookes[1] described and illustrated a case in which the patient died of intestinal obstruction 3 months after successful ligation. The prognosis of abdominal aneurism without operation is unfavorable. The duration of the condition is said to vary from 3 months to 3 years.

Aneurism of the popliteal artery. How the more modern conception of the surgery of the blood vessels comes to our assistance may be illustrated by a case of popliteal aneurism in a man aged 62 years. The aneurism was the result of a slight injury and had reached the size of a cocoanut. It had extended upward from the popliteal space to the opening in the adductor magnus. The patient was a bad surgical risk. He was fat and short necked. His heart was fibrillating, his systolic blood pressure was 220, his pulse rate 140. His foot was cold and gangrene was impending. The old operation of ligature of the femoral artery, would almost certainly have been followed by gangrene. An extensive operation on the sac or amputation, in all probability, would have been followed by death. A complete cure with restoration of the circulation in the limb followed resection of 1 inch of the artery in Hunter's canal and ligation of the femoral vein.[2]

Resection of the artery is a radical form of sympathectomy and in this case produced increased heat and blushing of the foot. The sheath of the artery above and below the ligatures was injected with alcohol, as recommended by Sampson Handley, to ensure against transitory vasoconstriction.

The advisability of ligaturing both artery and vein or the vein alone, when there is a dangerous diminution of the blood supply to a limb has only been recognized since the War. This recognition, reinforced by a better understanding of the surgery of the sympathetic nerves, has saved many limbs in recent years.

THE SYMPATHETIC NERVOUS SYSTEM

The assaults brought about by an unbalanced sympathetic nervous system have been

[1] J. Am. M. Ass., 1926.

[2] Med. Ann., 1929, p. 524.

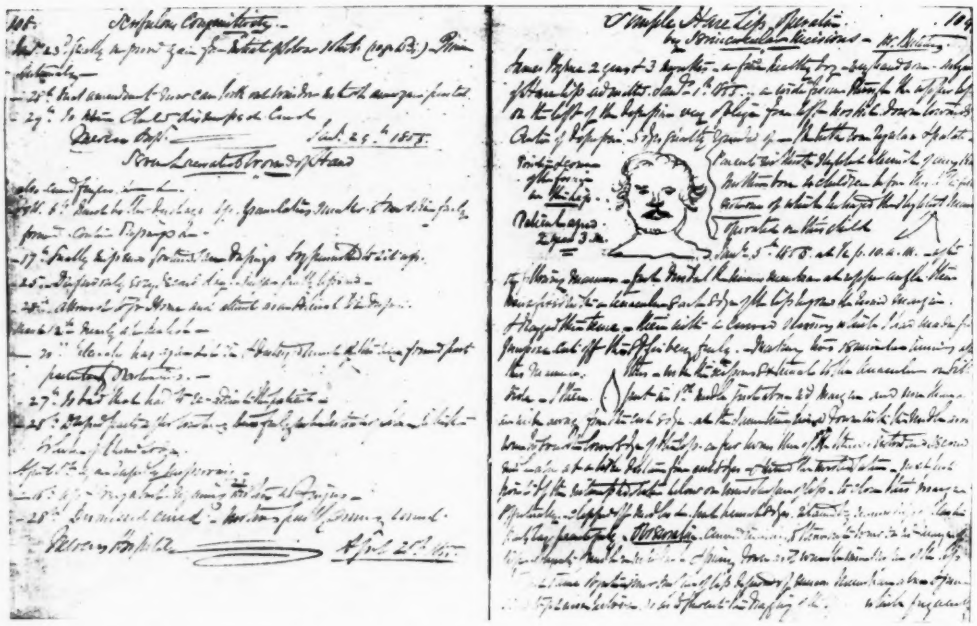

Fig. 5. Page from one of Butcher's voluminous case books, describing his operation for hare-lip.

countered by the surgeon in many fields. Pylorospasm and megacolon can be cured or relieved, spasm of the vesical sphincter causing urinary retention is coming under control, pelvic pain *per se* disappears under the magic wand of sympathectomy.

Raynaud's disease can now be conquered, and certain forms of polyarthritis have yielded to sympathetic resection.

HIRSCHSPRUNG'S DISEASE

This is a rare condition; I have had 2 cases under my care in 10 years. The colon may contain as much as 47 pounds of fæces, the circumference of the bowel may reach over 3½ feet. The bowels may act only once in 2 or 3 weeks, and in some cases several months have elapsed without an evacuation. Until the discovery of the rôle of the sympathetic in this condition physicians ordered surgical treatment, surgeons recommended a medical regimen.[1] In one-third of the cases the sigmoid flexure alone is involved and excellent results can be obtained by the simple operation of removal of the left sympathetic chain by a transperitoneal operation. The removal includes the second, third, and fourth ganglia.

In my second case the limited operation proposed by Rankin and Learmouth was performed (February, 1931). The child was aged 2 years. The pelvic colon when the abdomen was opened had the appearance and consistency of a small motor car tire.

In this case there was one unusual feature. The pelvic colon was not dilated for 2 or 3 inches above the pelvi-rectal sphincter, and the rectum was normal. X-ray photographs taken before operation showed an enormous loop of descending colon. The barium meal was visible a week after ingestion notwithstanding repeated washing out of the colon. The barium enema also revealed an enormous colon five or six times the normal diameter. The ascending colon was not dilated, and the transverse only moderately so.

The posterior peritoneum was divided from the promontory of the sacrum to the origin of the inferior mesenteric artery. The presacral nerve and its branches in the infant were not easily defined, but communicating filaments from the second, third

[1]Mercer. Edinb. M. J., 1931.

Fig. 6. Subclavian aneurism, showing the bullet and calcification in the sac.

and fourth sympathetic ganglia were divided and the area cleared of loose connective tissue. The inferior mesenteric artery near its origin was similarly denuded, but no very definite ganglia were found. The operation was rendered more difficult

Fig. 8. Thoracic aneurism from which wires were removed a month after introduction.

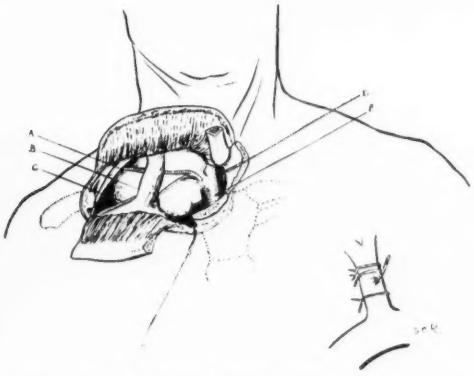

Fig. 7. Ligation of the innominate artery. The operation was planned at first for ligature of the subclavian artery but was modified later to ligature of the innominate artery. *A*, Transversalis colli; *B*, external jugular vein; *C*, suprascapular; *D*, portion of sternum and clavicle retracted; *F*, innominate artery. Inset shows ligatures proximal and distal to the thyroidea ima branch.

by the attachment of the mesocolon to the right of the middle line.

We had some difficulty in deciding whether we were dealing with tiny lymphatic vessels and glands, instead of nerve fibers and ganglia, in the course of the operation. In an infant, I am not sure that frank exposure of the lumbar sympathetic chain on the left side and division of the trunk above the second and below the fourth ganglion would not

Fig. 9. Side view of aneurism. The line marks the point of rupture. (One-half natural size.)

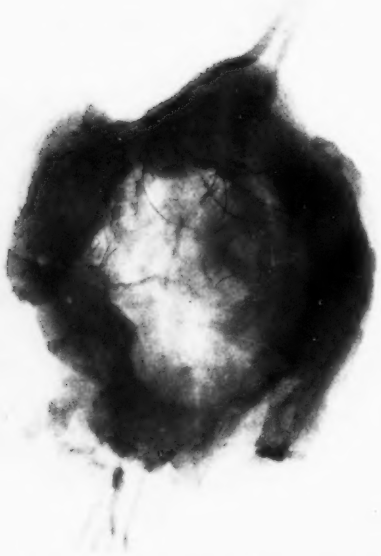

Fig. 10. Postmortem roentgenogram of abdominal aneurism 4 years and 8 months after operation. Colt's wires are seen in the sac.

be the more satisfactory operation, ramisection being performed at the same time.

The boy's constipation was completely relieved by the operation, and this relief has continued. After operation, a full sized sigmoidoscope was passed through the pelvi-rectal sphincter on a few occasions, the colon being emptied by means of an irrigating tube. Two months after operation a barium meal and enema demonstrated the pelvic loop of colon still dilated, but greatly reduced in diameter. The transverse colon was also considerably reduced. Seven months after operation dilatation was still present, but there was slight further improvement. The umbilical girth at the time of operation was 23¾ inches. Five days later it was 21¾ inches.

KIDNEYS AND PROSTATE

It has been pointed out that Murphy in his lectures on the surgery of the urinary tract laid great emphasis on the significance of back pressure in cases of prostatic obstruction.

Success depends on the relief of this back pressure, and it is an accepted fact that this relief must be gradual. Back pressure, renal insufficiency, cardiovascular changes, and uræmia, go side by side as time advances with prostatic enlargement. It is traditional that sudden decompression, either by uncontrolled cystotomy or by primary prostatectomy is followed by a recoil carrying a high mortality. The engorgement of the kidneys on sudden release of pressure is not surprising when we remember that the whole of the blood of the body passes through the kidney every few minutes. The other side of the picture shows the reparative phenomena which follow gradual decompression. Renal cells, like hepatic cells, and myocardial cells, have a definite power of regeneration if the causes producing degeneration are removed. In old standing cases, some of the kidney is irreparably damaged; some is damaged but is capable of regeneration, and there is probably a residue in most cases which has not yet become embarrassed.

In cases of overdistention of the bladder the path of safety is not the inserting of a catheter and the withdrawal of small amounts

Fig. 11. Hirschsprung's disease. Condition of the descending colon before operation. Note the undilated loop of pelvic colon below.

of urine every few hours. A few ounces (100 cubic centimeters) of urine, withdrawn from a distended bladder, may induce renal and circulatory shock.

For many years in Mercer's Hospital we have gradually decompressed distended bladders by allowing the urine to flow drop by drop by means of a reversed Murphy drip apparatus attached to an in-dwelling catheter. If this apparatus is not at hand, a rubber catheter is passed. It is clamped or plugged at the end to prevent urine escaping. A hypodermic needle is inserted through the rubber wall of the catheter, and through this needle the urine drips slowly until danger is passed. An ureteral catheter passed into the bladder acts in the same manner.

The necessity for gradual decompression is not confined to the urinary tract. The same problem arises when we are dealing with medical problems, such as high blood pressure.

Fig. 12. Hirschsprung's disease. Condition of colon 3 months after operation.

Fig. 13. Child aged 2 years six months after conservative sympathectomy for Hirschsprung's disease. The constipation is cured, the distention is reduced (girth of abdomen at operation 23¾ inches, now 21¾ inches) but persists.

It confronts us when there is back pressure on the liver, it is a factor in cases of ascites and intestinal obstruction. It faces us again in cerebrospinal lesions, in acute empyema, in hydramnios, hæmatocolpos, and glaucoma. Thus medicine, surgery, gynecology, and opthalmology, are all concerned in the fatal significance of a severe recoil following sudden decompression.

The general problem so far as treatment is concerned might, I think, be expressed as follows, in the terms of a law: *When an organ or system is suffering directly from pressure effects or indirectly from back pressure, the greater the pressure the more gradual should be its relief.*[1] Hippocrates indeed drew attention to this fundamental consideration in the following aphorism given to me by Dr. T. P. C. Kirkpatrick:

ὁκόσοι ἔμπυοι ἢ, ὑδρωπικοὶ τέμνονται ἢ καίονται ἐκρυέντος τοὺ πίου καὶ τοῦ ὕδατος ἀθρόου, πάντως ἀπολλυνται.

"Purulent or hydropsical cases who are lanced or cauterized, water and pus flowing out together, perish completely." (Aphorism of Hippocrates, Sect. vi, No. 27.)

[1]Wheeler. Canadian M. Ass. J., 1931, iii 8.

Fig. 14. Recurrent prostate. The prostate was removed with "cure" of patient. Symptoms recurred 12 years after operation. Examination revealed advanced obstruction from a regrowth of the gland. It was removed piecemeal a second time by enucleation and dissection. The illustration shows the second prostate.

RECURRENT PROSTATE

Recently I had under my care a man aged about 75 suffering from advanced uræmia, the result of prostatic enlargement. The prostate had been removed 12 years previously by Sir Conway Dwyer in the Richmond Hospital. For 12 years after operation he was completely relieved, but after this period the old signs and symptoms of prostatic enlargement gradually recurred until finally, the residual urine was at the maximum, and by chemical tests renal destruction was almost complete. A greatly enlarged prostate could be felt per rectum.

This was a case of recurrence of simple enlargement of the prostate. The condition is referred to by Sir John Thompson-Walker in the Lettsomian Lectures delivered before the Medical Society of London.[1] This writer draws attention to a number of cases in which the prostate appears to have been reconstructed after prostatectomy.

In the case I have just mentioned, gradual decompression and subsequent drainage for 6 months secured a sufficient return of renal function to permit a second prostatectomy. This was accomplished partly by enucleation and partly by dissection. The final recovery was complete.

Fig. 15. Solitary cyst removed from the upper part of the kidney with surrounding renal parenchyma.

SOLITARY CYST OF THE KIDNEY

A cyst surrounded by renal substance was removed from the upper pole of the right kidney of a woman aged 57 years, in September 1931. Painless hæmaturia and the presence of a smooth, painless enlargement of a right mobile kidney were the outstanding clinical features. Pyelography revealed the upper calyces occluded and deformed, and slight hydronephrosis on the left side. Biochemical

[1] Lancet, 1930, June 14, p. 1275.

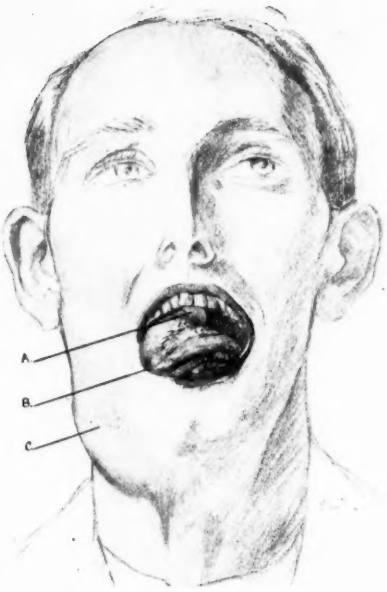

Fig. 16. Congenital laryngocele. *A*, Air containing protrusion on the dorsum of the tongue; *B*, tip of tongue deviated but could not be protruded; *C*, communicating air sac in the submaxillary region. Illustration was made from the patient before death.

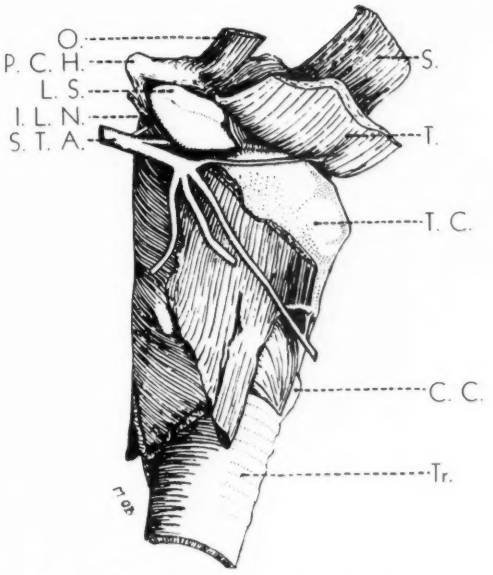

Fig. 17. Congenital protrusion of a laryngeal pouch. Drawing from a specimen in Trinity College, Dublin, by kind permission of Professor A. F. Dixon.

investigation showed a high blood urea 72 milligrams per cent, the urea concentration test revealed an excretion of 1.5 per cent urea 3 hours after the meal.

The cyst was about the size of a tangerine orange. On exposure, the kidney was found quite normal but for the upper pole which was involved in the cyst. It was removed by a wedge-shaped incision into the kidney substance. The cut renal surfaces were brought together by interrupted Halsted's stitches. The stitches were prevented from cutting through by the interposition of portions of detached muscle after the manner recommended by Walters. Recovery was uneventful.

Solitary cysts of the kidney are rare. Fullerton[1] says that up to the time of writing (1926) only 99 cases had been reported.

LARYNGOCELE

Murphy excelled in the realm of diagnosis. He could separate the essential from the non-essential factors with great rapidity and in a short time what appeared to be a complex tangle of contradictory signs and symptoms was straightened out and made simple.

The case to which I now draw your attention puzzled us considerably, but by applying the inductive methods of reasoning adopted by Murphy, its nature was finally made clear.

The patient was a man aged 24 years, who suffered all his life from a painless bulge or swelling in the right submaxillary region. This swelling was tympanitic and under pressure disappeared. The swelling moved and protruded with deglutition or coughing. The right side of the tongue and floor of the mouth were enlarged. On the posterior third of the dorsum of the tongue on the right side there was a soft conical projection about the size of a small lump of sugar. The tongue could not be protruded. Any attempt to do so resulted in deviation of the entire organ to the right side. Speaking was difficult. It was owing to the fact that his friends could not understand what he said that he came to hospital to seek advice. The swelling on the tongue and the swelling in the submaxillary region were connected. If the one was pressed upon, the other enlarged. It was obvious that the swellings were not solid, nor did they contain fluid. The introduction of a hypodermic needle into the protrusion on the tongue gave no information. After the injection

[1] Brit. J. Surg., xiv, 629.

Fig. 18. Laryngocele, lateral view. The protrusion on the tongue was injected with 10 cubic centimeters of lipiodol. Note the narrow connection between the lingual and submaxillary portions.

of lipiodol through the needle, X-ray photographs confirmed the fact that the tongue swelling and the submaxillary swelling were connected.

At this stage, the true condition was not realized. With a view to operative exploration, the patient was given colonic ether. He died suddenly before anæsthesia was produced.

On searching the literature the first clue to the nature of this case was obtained from a paper on malformation of the larynx by E. H. Bennett, published in the *Dublin Quarterly Journal of Medical Science*, vol. 40, 1865. Bennett was the first to discover a human larynx in which there existed fully formed laryngeal pouches which are normally found in a high state of development in some of the higher apes.

Bennett was dissecting in the region of the thyroid cartilage in Trinity College. His attention was arrested by a cystic structure which he opened accidentally on one side. A probe passed downward through the opening into the laynx. At first he thought that the condition was the result of disease, but he found a similar sac on the opposite side. Further investigation showed that the pouch occupied nearly all the space which is covered by the thin lateral portion of the thyrohyoid membrane. The lower border of the protrusion rested on the superior laryngeal vessels and nerve, and superiorly was in contact with the under surface of the great horn of the hyoid bone. On examining the interior of the larynx the probe passed through the sac from without, beneath the anterior part of the false vocal

Fig. 19. Laryngocele, anteroposterior view. Note the trickle of lipiodol toward the lateral wall of the larynx.

cords. It entered the ventricle of the larynx by an opening of oval shape, about three-fifths of an inch in length. The opening corresponded to the sinus of Morgagni.

Professor A. F. Dixon, professor of anatomy in the University of Dublin, kindly showed me another specimen from which the drawing (Fig. 17) has been made.

There is little doubt that the patient to whom I have referred was suffering from this congenital deformity. The appendix of the laryngeal ventricle on the right side had extended through the thyrohyoid membrane in an upward direction behind the body of the hyoid bone to the floor of the glosso-epiglottic fossa.

There is no mention in surgical literature of the extension of these extra laryngeal pouches into the tongue. In the apes they extend down the neck, often as far as the clavicle or

Fig. 20. Multiple lesions. Patient's breast removed for cancer 5 years ago. Thought to be suffering from metastasis. Investigation revealed bilateral renal calculi and simple ulcer of the lesser curvature of the stomach; gastrectomy; recovery.

between the two heads of the great pectoral muscle into the axilla. They attain a very large size.

Von Bergman[1] mentions laryngocele and congenital air cysts in connection with swellings of the neck. He and other German writers refer to the danger of sudden death from suffocation when the sac becomes overdistended.

The fact that the lipiodol did not enter the larynx in the case under review may be explained on the hypothesis that the interior opening was either very minute or of a valvular nature.

In his *Anatomy*,[2] Quain states that the blind end of the appendix sometimes passes upward, lateral to the aryepiglottic fold and behind the body of the hyoid bone, so as to lie close to the floor of the glosso-epiglottic fossa. In this volume reference is made to Sclavunas who collected reports of 10 cases of congenital

[1]System of Prac. Surg., ii, p. 147.

[2]1914, vol. ii, pt. 2, 169

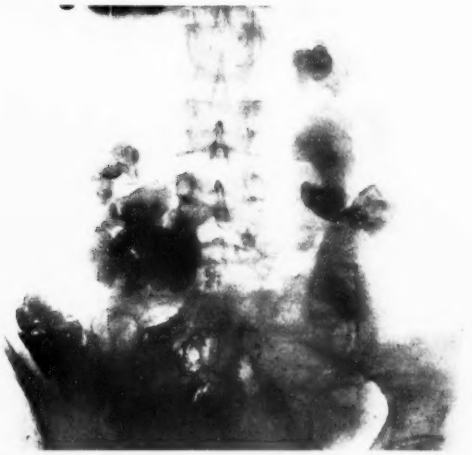

Fig. 21. Same case as in Figure 20, showing the large branching renal calculi.

laryngocele. Two were bilateral, 4 were unilateral, and 4 were bilateral but with a larger sac on one side.

Andre Forster, professor of medicine in Strasbourg, gives a very full illustrated account of the laryngeal sac in apes.[3]

MULTIPLE LESIONS

It is like pushing an open door to mention to an assembly such as this the necessity for complete and thorough examinations in all cases, but diagnostic endeavor in small surgical centers has a tendency to become concentrated and focused on one prominent lesion. If a patient is found after examination to be suffering, say from duodenal ulcer, it is forgotten that gastric ulcers may also be present, and the case further complicated by disease of the pelvic organs, the kidneys, or the gall bladder.

I have been struck with the number of patients who come for operation suffering from cholelithiasis who were found to have a midline scar below the umbilicus for the correction of what was believed to be some uterine or ovarian disease. This scar has so frequently been in evidence (in fat women who have borne children) that many students in Dublin regard it as supporting evidence of the diagnosis of biliary stones.

[3]Arch. Anat. Histol. Embryol. 1925, iv 45.

Fig. 22

Fig. 23

Fig. 24

Fig. 22. Pensioner K. Wounded 1918. The right arm hangs from the trunk by a pedicle containing the vessels and nerves. The skin, deltoid muscle, and upper end of the humerus were blown away.

Fig. 23. Roentgenogram taken immediately after operation; 4 inches of the graft is intramedullary, the upper portion is in contact with the glenoid cavity, the coracoid, and the acromion.

Fig. 24. Patient 14 months after operation holding a vessel 5½ pounds in weight at arm's length for a time exposure photograph.

Fig. 25. Result 5 years after operation. Note the medullary cavity in the graft and firm ankylosis with scrofula.

(Figs. 22–25 from Brit. J. Surg., 1921, ix, 34.)

Fig. 25

An interesting case with multiple abdominal lesions was admitted to Mercer's Hospital in October, 1931.

She was aged 56. Five years previously her breast had been removed for carcinoma. She had lost weight, she was anæmic, and she suffered from constant pain in her upper abdomen. Metastatic growth was diagnosed without full investigation in the first instance. X-ray photographs showed a chronic penetrating ulcer in the lesser curvature of the stomach. Cystoscopy revealed that the urethral orifices were normal but that pus was flowing in large quantity from the right side. The blood urea was high. The urea concentration test after 5 hours gave a 1 per cent excretion. Further X-ray photographs demonstrated large branching calculi in both kidneys. The middle portion of the stomach was removed under gas oxygen and local anæsthesia. The ulcer was found to be non-malignant and the patient made a rapid recovery. No doubt uræmia will eventually supervene, but for the moment her pain is gone, and the dread of cancer has been stilled.

Finally, I will mention 2 cases: one of bone grafting to replace the upper end of the humerus, and the other, arthroplasty for ankylosis of both knees. The operations were performed exactly as Murphy dictated and the result

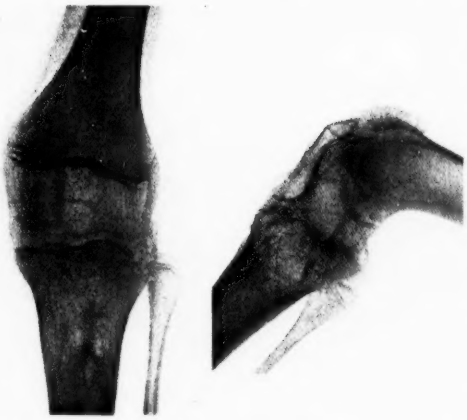

Fig. 26. Right knee joint ankylosed in extension.
Fig. 27. Left knee joint ankylosed in flexion.

Fig. 30. Snapshot of child walking, right knee.
Fig. 31. Snapshot of child walking, left knee.
(Figs. 26–31 from Brit. J. Surg., 1921, ix, 34.)

obtained were entirely due to the doctrines he preached.

Figure 22 shows a soldier, aged 25, who was wounded toward the end of the War. The right shoulder below the acromion process was carried away *en masse* —skin, muscles and bone. Only a pedicle remained on the inner side carrying the main vessels and nerves by which the arm hung helplessly to his side. All scar tissue was cleared away and the upper end of the bone was freshened. A bone-graft 9 inches long taken from the tibia was driven for 4 inches into the medullary cavity. The upper portion was placed in contact with the glenoid cavity. Three months later the graft had thickened, but there was loss of density in the picture owing to the destructive powers of the osteoclasts being more apparent in the X-rays than the regenerative powers of the osteoblasts. Six months after operation firm bony union was shown at the upper end of the new humerus. The intramedullary portion of the graft has become partially absorbed. Nine months after operation strong new bone had replaced the slender original graft. Fourteen months after operation,

Fig. 28. Amount of voluntary flexion in left knee joint 2 years after operation. Note the patella "turned turtle."
Fig. 29. Amount of voluntary flexion in right knee joint 18 months after operation.

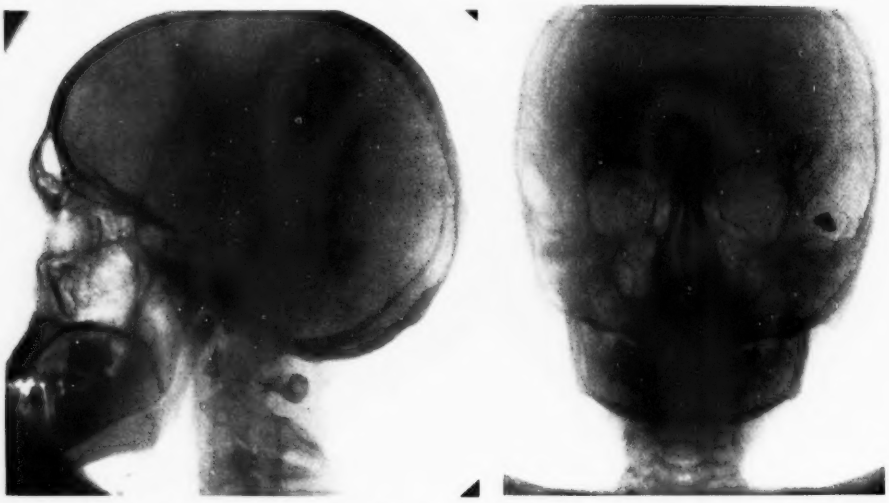

Fig. 32. Lateral and anteroposterior views of patient with bullet in "the association area" of the brain.

although movements of the shoulder were limited, the strength of the arm left nothing to be desired.[1]

After five years an X-ray photograph shows the humerus completely reformed (Fig. 25).

ARTHROPLASTY

The accompanying illustrations (Figs. 26–31) show the result of Murphy's arthroplasty in the case of a girl aged 11 years operated upon in September, 1919.[2]

FOREIGN BODY IN THE BRAIN

The following case is mentioned because the history given by the patient is picturesque and because it is unusual for a bullet to enter the brain without the patient knowing that he had been severely injured.

A patient aged 21, was wounded in the head in May, 1921, while engaged in street fighting in Dublin. He received what he believed then to be a small scalp wound to the right and above the occipital protuberance. He was dressed but not detained in the hospital. No X-ray was taken. He noticed at the time of his wound sounds of music in his ears as if there was a band with drums in close proximity. A fortnight later he was smoking a cigarette when a black dot appeared in his right lateral field of vision. The speck moved medially, growing larger and becoming bright until it appeared as a blinding light in the center of his visual field. At this stage he became totally blind. He never lost consciousness, but his memory was stimulated and distorted. He imagined he saw men firing at him, while he was surrounded by comrades. Headache and vomiting supervened. These aural attacks lasted about 20 minutes and recurred once or twice a month for 4 years. In the intervals he was well, and led an energetic life, but the re-appearance of the black spot when least expected like the ghost of Hamlet left him morbid and alarmed.

Clinical examinations were entirely negative; there was no paralysis, motor or sensory; no alterations in the reflexes, and both fundi were normal.

X-ray examinations disclosed that the nickel case of part of a conical bullet was lying in the base of the brain just behind the petrous portion of the temporal bone at the level of the eminence in the superior semi-circular canal. To approach the bullet in a direct line it would have been necessary to open the skull behind the vertical line dividing the mastoid into equal parts. The direct route would have led through the sigmoid portion of the lateral sinus and some of the posterior branches of the middle meningeal artery.

Operation, December 10, 1925. The skull was opened at a level above the location of the bullet and when the meninges were divided, a finger was passed under the temporal lobe in front of the cerebellum. After some difficulty a feeling of resistance was detected with the finger, and with the latter *in situ* a forceps was pushed through the temporal lobe from above. A mass about the size of an olive was located and was enucleated. There was a line of cleavage between the mass and the brain substance. On removal, the "tumor" proved

[1] Wheeler. Brit. J. Surg., 1921, ix, No. 34.

[2] Wheeler. Brit. J. Surg., 1921, ix, No. 34.

to be composed of fibrous tissue encapsulating the conical point of the bullet. Before it could be extracted, it became necessary to nibble away bone toward the base of the skull. The sigmoid portion of the lateral sinus was wounded, but the control of bleeding was not difficult.

During the removal, some brain matter on the lateral surface of the temporal lobe was injured and removed. In bulk, the brain matter sacrificed was about the size of the tumor.

The after history was uneventful. A month after the operation the patient appeared quite well. He had no recurrence of his previous attacks.

Before operation, a model of a brain was placed in a skull, and with the aid of the X-rays, it was possible to map out the exact position of the foreign body encapsulated in the fibrous mass. It lay underneath the junction of the temporal and occipital lobes. The area involved was "the association area" which lies between the visual area behind, and the portion of the brain concerned with hearing, in front.

It was interesting to correlate these findings with the clinical history given by the patient. There were just three points in the history: (1). The sounds of band music on the day he was wounded. (2). The distorted visual phenomena occurring on an average twice a month for over 4 years. (3). The memory of troops firing at him, while he was surrounded by his friends.

It may be surmised that the association area in the brain from which the foreign body was extracted is one of the resting places of the intellect, which brought to memory hearing and sight. It is the development of such a center (absent at birth and in the lower animals) which accounts for the fact that Beethoven was able to write and conduct his beautiful symphonies at a time when he was overwhelmed with deafness and deprived of the faculty of which he stood most in need.

AN EXPERIMENTAL AND CLINICAL STUDY OF THE USE OF RADIUM IN THE BRAIN[1]

LOYAL DAVIS, M.D., F.A.C.S., AND MAX CUTLER, M.D., CHICAGO
From the Department of Surgery, Northwestern University Medical School and the Tumor Clinic of Michael Reese Hospital, Chicago

THE many accomplishments of neurological surgery in the past thirty years have been made in the fields of surgical technique, diagnosis, and pathology. The perfection of the meticulous details of an osteoplastic craniotomy with complete hæmostasis, particularly during the removal of a tumor; replacement of the bone flap; and an accurate wound closure without drainage was the first important contribution. Attention was then turned to matters pertaining to diagnosis. Today, the time has passed when headaches, papillœdema, and vomiting must be present before the diagnosis of an intracranial tumor may be made.

Of equal, if not of greater, importance than these matters was the microscopical verification and classification of the tumors exposed and a correlation of the pathological picture with the clinical course of the patient before and after operation. Today the neurological surgeon must be able to foretell not only the precise situation of the lesion but its probable pathological character as well.

Though remarkable progress has been made, there are still many intracranial tumors which cannot be removed completely by surgical means. This is particularly true of the gliomata, which constitute about 42 per cent of all intracranial tumors. The correlation of the pathological and clinical characteristics of this group of tumors has made their subdivision possible, so that we are now cognizant of the difference in malignancy between the astrocytomata on the one hand and the glioblastomata on the other. However, the present surgical methods employed, which consist of removal of the tumor by suction; by resection of large portions of the hemisphere; or by the electrosurgical scalpel are not completely satisfactory. All of these methods entail a large surgical risk, a gross destruction of brain tissue with the possibility of many neurological residual symptoms, and finally, there is the possibility of leaving tumor tissue behind.

There should be no question that any suggestion for improvement in therapy must be based upon surgical exposure of the tumor, and its microscopical verification. Any therapeutic agent which could be employed so that the tumor might be inactivated *in situ*, without destruction to surrounding normal brain tissue, would be a progressive step in the surgical therapy of the gliomata. The use of radium implanted directly into the tumor suggests itself immediately.

Danysz (6) was probably the first to study the effects of radium upon the central nervous system. In 1903, this investigator placed a radium bearing tube 1 centimeter in length over the spine and part of the skull of a mouse 1 month old. Within 3 hours the animal developed paralysis and ataxia; after 7 hours, convulsions; and 18 hours later the animal died. Mice 1 year old exposed in a similar manner died 6 and 10 days later. Three guinea pigs 8 to 12 days old in which the same radium tube was placed beneath the skin over the lumbar cord for 24 to 48 hours developed complete paralysis of the posterior part of the body after 1 to 3 days. Adult guinea pigs and rabbits treated in a similar manner showed no lesion of the spinal cord but succumbed 3 weeks later to infection. An adult rabbit exposed to the radium tube for 8 hours was normal for 2 days and then developed hemiplegia on the third day.

Later the same author (7) exposed mice confined in wooden cages to 23 milligrams and 50 milligrams of radium bromide which was fastened in a hole in the lid of the cage. The time of exposure varied between 4 hours and 30 days. The animals developed alopecia, dermatitis, and paralysis and some died. Microscopically, the tissue showed vascular changes consisting mainly of ruptured capillaries, but no changes could be demonstrated in the nerve cells.

In 1903, London (11) exposed young mice in a small glass cage to 30 milligrams of radium

[1] Presented before the Clinical Congress of the American College of Surgeons, St. Louis, October 17–21, 1932.

bromide fastened on the cover. All the animals died after 4 or 5 days. The symptoms were insomnia, restlessness, and weakness which was followed by paralysis and coma. At postmortem examination hæmorrhages were present in the subcutaneous tissues and in the dura over the cerebral cortex. In subsequent experiments (12) he found atrophic nerve cells in the spinal cords of 3 rabbits which had been exposed for long periods to 25 milligrams of radium.

Heineke (9) found deep hæmorrhagic areas with softening of tissues at the site of application in a rabbit which had carried 20 milligrams of radium bromide on its head for 14 days. The rabbit was well for 3 weeks and died suddenly with spastic symptoms.

An intense reaction in the meninges was observed by Scholtz (20) in rabbits in which 25 milligrams of radium bromide were fastened to the head for 1 to 3 hours.

Obersteiner (13, 14) observed large and small hæmorrhages in the cerebrum, cerebellum, and medulla with perivascular round cell infiltration. The nerve cells remained unaltered in mice whose heads were exposed to diffuse radiation. The severity of the symptoms depended upon the age of the animals, the duration of the exposure, and the amount of radium used. The symptoms were for the most part a direct or indirect expression of circulatory and metabolic changes produced by the radium. Similar effects—punctate hæmorrhages without changes in the nerve cells—were noted by Alquier and Faure-Baulieu (1) in the brains and the cords of rabbits which were exposed to external radium applications.

In 1911, Horsley and Finizi (10) placed 55 milligrams of radium bromide on the pre- and postcentral gyri of monkeys for 2½ to 4 hours. The rays were filtered through 0.5 millimeters of platinum and 1 millimeter of rubber. None of the animals showed symptoms after 26 to 45 days, when they were sacrificed. Examination of the brains showed thickening of the dura with infiltration of the pia and arachnoid by erythrocytes and leucocytes. There was an endothelial hyperplasia of the blood vessel walls, in some places so marked as to occlude the lumen. The first two layers of the cortex were the seat of punctate hæmorrhages. No changes in the nerve cells were discovered.

Williamson, Brown, and Butler (21) placed 50 milligrams of radium element filtered through 0.4 millimeters of platinum upon the motor area of the cerebral cortex for 4, 6, 12, and 18 hours. They found that within a radius of 4 millimeters from the tube a 12 hour exposure caused complete destruction of brain cells and interstitial tissues. The blood vessels showed marked thickening, and hyalinization without rupture of the walls. In a second zone, 1 millimeter in diameter, outside the former area, the cells were not destroyed completely but showed distinct signs of degeneration. The authors concluded that 50 milligrams of radium acting for 18 hours produce a destructive effect upon the tissues within a radius of 5 millimeters. The effect upon the blood vessels varied with the dose and the distance from the radium focus.

Bagg (2) studied the effects of glass capillary seeds containing radon upon the mammalian brain. He found that the tissue in the immediate vicinity of the tube became completely necrotic. Surrounding this area was a zone of polynuclear leucocytes beyond which there was a zone of hyperæmia. At the end of 24 hours the zone of necrosis was 1 millimeter wide. The maximum effect was reached at the end of 2 weeks when the lesion was 1 centimeter in diameter. Each glass capillary seed was 3 millimeters long, 0.4 millimeters in diameter, and 0.1 millimeter thick.

In an effort to study the functional rôle of the group of nerve cells composing the corpus striatum, Bagg and Edwards (3) implanted similar glass radon capillary seeds into the corpus striatum of dogs. One tube was implanted into each dog by means of a trocar introduced through a 2 millimeters trephine opening into the skull. Six weeks after insertion there was a localized destructive lesion consisting of an inner area of necrosis 4 millimeters in diameter surrounded by a ring of fibrin and then an outside zone 2 to 3 centimeters wide which showed œdema, and a rich cellular exudate. Microscopical examination of the lesion showed a central, partly cystic, area of softening, discolored by methæmo-

globin. In this area there was a collection of large, round cells distended by fat droplets and yellowish granular pigment. The lesions were sharply demarcated and the surrounding brain tissue showed no alteration in structure.

Pendergrass, Hyman, House and Rambo (16) have studied the effects of radium upon the normal tissues of the brain and spinal cord of dogs, both by surface applications and implantation. The surface applications were made over the parietal cortex, the radium tube being placed on the dura. In the implantation experiments two needles were inserted in each dog through an opening over the parietal lobe. Surface application was made with platinum or silver tubes of 0.5 millimeter wall thickness, 2.8 centimeters long, and 3 to 5 millimeters wide. Steel needles used for implantation measured 2.8 centimeters long, 1.5 millimeters wide, and contained 10 to 12.5 milligrams of radium element. With external applications all of the dogs which received 1,150 milligram hours or less showed no symptoms. All of the animals which received 1,400 milligram hours or more died. Two of the dogs in which interstitial radiation was used developed general peritonitis and 1 developed meningitis from which they died. These same authors also found that an exposure to 600 milligram hours of radium over the spinal cord caused marked clinical symptoms. Areas of necrosis were found two segments above and below the lesion of direct contact. In addition to the local area of necrosis an increase in weight of the irradiated hemisphere indicated the presence of œdema. The authors state that the cause of death in the dogs was not due to a local effect upon the brain but to toxæmia. They noted that many changes were found following exposures which gave no clinical signs or symptoms, and they concluded that an exposure of normal brain tissue up to 1,150 milligram hours is compatible with life.

Cairnes and Fulton (4), using cats and monkeys, implanted radon seeds 1.5 centimeters long with 0.3 millimeter platinum filtration alongside the spinal cord but extradural in the dorsal region. With large doses (31 millicuries) signs of weakness of the hind extremities appeared 30 hours after operation. The paraplegia became complete 3 to 4 days after the onset. With smaller doses the time of onset of the first symptoms was later, and the appearance of the complete paraplegia correspondingly delayed. In cats any dose greater than 9.5 millicuries produced complete paraplegia. Monkeys proved more resistant than cats because a dose of 12 millicuries produced only slight weakness. The first symptom exhibited was loss of the sense of position which was followed several hours later by motor weakness. The animals invariably passed through a stage of extension before developing a characteristic, complete, flaccid paraplegia.

Carimichael and Ross (5) performed a series of experiments in which they placed radon seeds within and upon the dura mater and radium needles upon the dura mater. They used 5 millicuries of radon with 0.3 and 0.5 millimeters of platinum filters. The animals were sacrificed from 1 hour to 61 days during all of which time the radon seeds or radium were in place. They concluded that following the use of radon seeds the endothelium of the blood vessels showed the first changes; then an emigration of leucocytes occurred, followed by local destruction of the cerebral cortex and finally hæmorrhage. Fat was found in the blood vessels and after 94 hours thrombosis had occurred. Microglia cells loaded with fat were found in the subarachnoid space and in the perivascular spaces. The nerve cells stained poorly, neurofibrils were fragmented, and the myelin sheaths were segmented and stained faintly. It was found that repair was evidenced after 212 hours of exposure by a proliferation of astrocytes. One-half milligram needles of radium showed a very local effect. The authors reported that they had used radon seeds in 2 cases of pituitary tumor; 1 choroid plexus papilloma; 1 meningioma; 1 metastatic carcinoma; and 3 gliomata.

Sargent and Cade (19) prefer the implantation of radium needles into tumor tissue, but believe that interstitial radiation has a limited field because of the effect of radium upon blood vessels. These authors have used radium needles in several patients with intracranial gliomata and record dosages as large

as 3,721 and 5,184 milligram hours. They also used external, or surface, irradiation with intermittent exposures of from 14 to 18 hours daily for 2 to 3 weeks or from 4 to 6 weeks if no interstitial radiation had been used. Three of the cases reported upon were oligodendrogliomata, a type of glioma which ordinarily has a good prognosis.

Ross (18) in a later paper, has pointed out that radon seeds produce a local necrosis of cerebral tissue associated with hæmorrhage and that radium element produces a more uniform radiation than radon. It would appear that Ross assumes that the changes produced immediately about the needle tract are due to the effect of radium.

The effects of implanting radium into brain tumors have been reported by various observers. In 1920, Frazier (8) reported 3 cases. The first patient was 13 years of age and had an inoperable tumor of the cerebellopontile angle. Eighty-five milligrams of radium were implanted in the tumor for 15 hours. Three years later there were signs of recurrence and a second radium implantation was performed. Six years after the first treatment the patient was still living and while symptoms of cerebellar disturbance were still present the condition was stationary. The second patient was a child with a serious disturbance of cerebellar function. A suboccipital decompression and radium implantation resulted in extraordinary improvement. Eight years after the treatment the child was reported to be in perfect health. There is no information upon the amount of radium or the technique employed in this case, and the nature of the tumor was not verified by microscopic examination. The third case was that of a patient 30 years of age who had been operated upon 19 months before admission because of disturbance in vision due to a pituitary lesion. Radium was applied to the pituitary body through the posterior nares. The treatment was followed by marked improvement and there was no evidence of recurrence 3 years later. The author mentions that in no instance had a glioma been benefited by radium treatment.

Pancoast (15) states that, based upon the work of Pendergrass, the surface dose of radium to the brain over a limited surface area

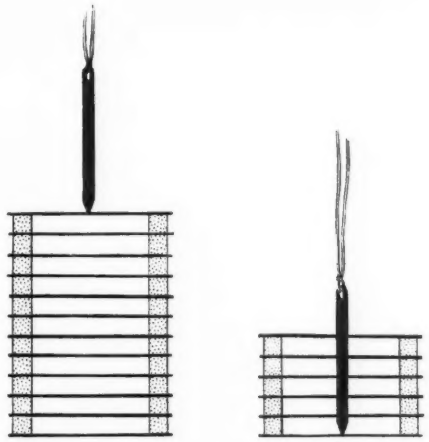

Fig. 1. Diagram to show methods of exposing photographic films to the radium needle.

should not exceed 1,400 milligram hours, though Frazier has given 1,445 milligram hours to a large cerebellar tumor without untoward results. He was of the opinion that radium implantation alone in safe doses is inadequate for the tumor and must be supplemented by external radiation.

Recent developments in our knowledge of radiation therapy have established certain fundamental principles that have an important bearing upon treatment. Thus it has become recognized that an optimum time interval exists during which a tumor reacts best to radiation. Exposure of the growth during a shorter period results in failure to gain a maximum lethal effect upon the tumor cells. Exposure over a longer period results in the establishment of a state of radio-immunity. The importance of utilizing the most penetrating rays of radium has led to the use of adequate filtration, and a recognition of the significance of homogeneous distribution of radiation has resulted in the use of external radiation whenever possible and multiple implants when interstitial irradiation is indicated.

Since these principles have become recognized, it is not difficult to explain many of the failures of radiation therapy under the older technique. The use of glass radon seeds, for

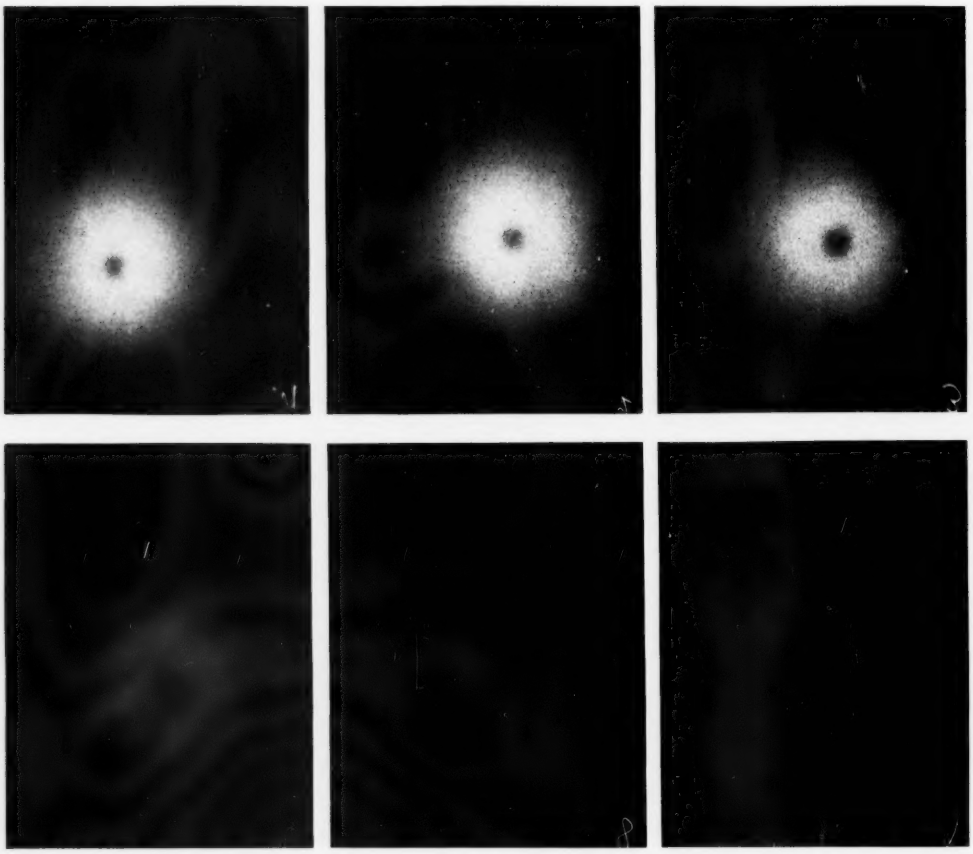

Plate A.

Fig. 2. Exposures of photographic films to 1 milligram radium needle. In Plate A the needle was suspended above films which were separated by a distance of 3 millimeters. The uppermost three photographs are the first three films, reading from left to right. The lowermost three films are the films which were the farthest away from the radium needle. The film in the lowermost right hand corner was 24 millimeters away from the tip of the needle. Note the varying size of

example, invariably caused necrosis on account of the absence of filtration, and the frequent failures of gold implants can be explained on the basis of inadequate filtration and the difficulty of effecting a uniform distribution of radiation except in lesions of limited size.

These considerations have resulted in important changes in technique in recent years. The ideal form of radiation therapy is that which permits the delivery of an adequate, uniform dose of penetrating irradiation over a prolonged but limited interval; for example, by the use of a large quantity of radium at a distance. In the treatment of the more radio-resistant tumors, however, the amount of radiation that can be delivered to the lesion by external radiation may be inadequate and interstitial radiation becomes necessary in order to deliver an adequate dose to the tumor. Under these circumstances the use of multiple weak radium foci adequately filtered and uniformly distributed becomes the method of choice. With a few, isolated exceptions removable platinum iridium needles of 0.5 millimeter wall thickness, containing radium element, have proved to be superior to

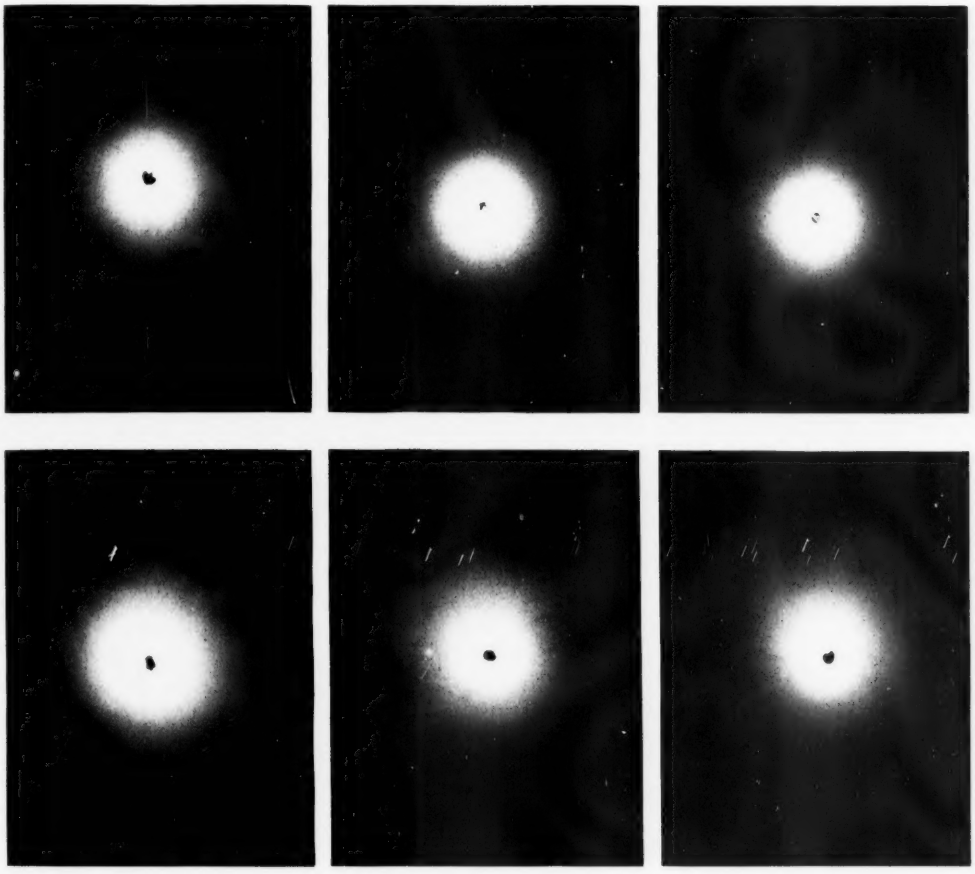

Plate B.

the exposure effect upon the film. In Plate B the radium needle was placed through the films as illustrated in the diagram in Figure 1, b. Note that the exposure effect upon the films was equally as strong in the lowermost as in the uppermost film and that the extent of the radiation from the needle was uniform along its entire course.

any other method of interstitial radiation. The radium element is distributed throughout the platinum needles in such amounts that the total dose determined by clinical experience is delivered over a prolonged period of approximately 5 to 7 days. This distribution of radium permits the use of a small quantity of radium over a period of 120 to 168 hours rather than a larger quantity over a period of 10 or 12 hours. In the treatment of cancer of the tongue, for example, the use of this method has proved highly successful. Within the last few years the use of removable platinum radium needles has been extended to the treatment of other neoplasms, notably inoperable carcinoma of the breast.

Although radium implantation has been practiced in tumors of the brain and numerous studies have been made upon the effect of radium on normal brain tissue, most of these observations were conducted before these basic principles were fully recognized and the radiation was not executed in accordance with the newer technique embodying these factors.

The prime purpose of these experiments was to study the effect of removable radium

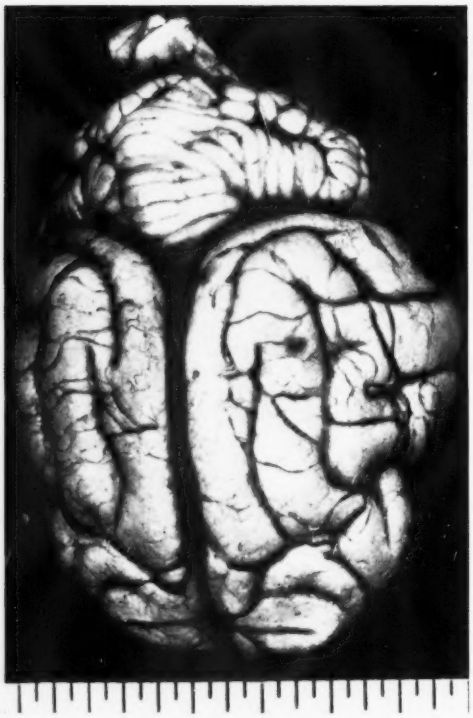

Fig. 3. Brain of Cat Ra No. 6. Note the discrete wound in the cortex made by the radium needle and the absence of reaction about it.

needles upon the normal brain tissue of animals and man under conditions in which the irradiation is delivered according to the modern concepts of adequate filtration, prolonged exposure, and homogeneous distribution.

EXPERIMENTS

Ten cats, 9 dogs, and 1 monkey were used as the experimental animals. Platinum iridium needles with walls 0.5 millimeter thick, 22 millimeters long, which contained 1 milligram of radium element, were employed for implantation.

With two exceptions the radium needles were implanted in the parietal area of the cerebral hemisphere. In 2 cats, implantations were made into the cerebellar hemisphere. In one series, one needle containing 1 milligram of radium was implanted and left in place for 24, 48, 72, 96, 120, and 216 hours. The animals were sacrificed at the end of those periods. In another series, 4 milligrams of radium were implanted for periods of from 48 to 216 hours; the total number of milligram hours therefore were from 192 to 864. After the radium needles were removed the animals were allowed to live and were sacrificed at intervals of 20 to 168 days.

It became evident early in the course of the experiments that the animals would tolerate a larger number of radium needles provided a small amount of bone was removed and the dura mater was left open over the site of the implantations. The needles were introduced into the brain at intervals of about 1 centimeter about the circumference of a circle. The fine silk sutures attached to the eyes of the needles were placed beneath the temporal muscle. It was believed that each radium needle would exert its maximum effect at a distance of 1 centimeter and that in applying this method of therapy to intracranial tumors it would be necessary to place the needles within the tumor at 1 centimeter intervals.

In an attempt to demonstrate the limits of the area of radiation from a 1 milligram radium needle of the type used, we exposed a pack of 12 photographic films separated at intervals of 3 millimeters. The needle was suspended above the films in a darkened room for 24 hours (Fig. 1). It will be noted that the intensity of the shadow varies so that the bottom film showed no registration from the radium. Therefore, the maximum radiation occurs within 1 centimeter from the tip of the needle. In another pack of 6 films, also separated by a 3 millimeter interval, the needle was inserted through the films (Fig. 2). It may be seen that along the entire length of the needle the area of radiation is of the same intensity and size.

None of the animals, regardless of the number of milligram hours of exposure and the time of sacrifice, showed any symptoms of damage to the central nervous system. It is true that the implantations were made in a relatively silent area of the cortex but it is clinical proof of the fact that the radium did not injure the brain at any great distance from the site of its implantation.

The brains were removed in every instance after formalin fixation *in situ* and there was

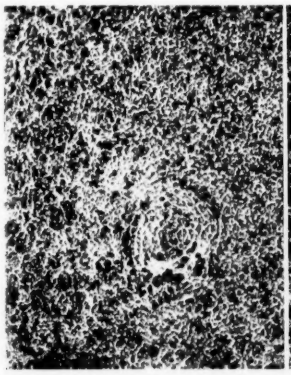

Fig. 4.

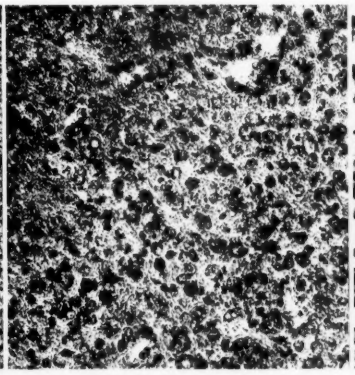

Fig. 5.

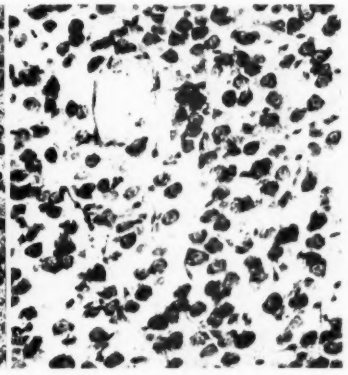

Fig. 6.

Fig. 4. Photomicrograph to show the thrombosis of a small vessel in the cortex about the region of the needle tract.

Fig. 5. Photomicrograph that shows a large number of gitter cells loaded with fat about the tract of the needle wound. (Herxheimer fat stain.)

Fig. 6. Normal nerve cells in an area 6 millimeters away from the needle tract. (Cresyl-violet stain.)

no operative or therapeutic mortality. Coronal sections of the brain were embedded in paraffin and in celloidin. Microscopic sections were cut at 10 millimeters to 30 millimeters in thickness and were stained by the hematoxylin-eosin, Van Gieson, Cresyl-violet, and Weil methods. Frozen sections were made and stained by the Herxheimer; Cajal nerve fiber and gold sublimate methods; Kanzler's method for microglia; Hortega's IV; and Penfield's combined method for oligodendroglia and microglia.

The brains of two animals may be described as typical of the series in which the radium was inserted and the animals sacrificed at intervals of 24 to 216 hours. In Cat Ra No. 6 a 1 milligram needle was inserted in the left parietal cortex on December 22, 1931, and the animal was sacrificed December 28. During that interval the animal had been quite normal in every respect. The cortical vessels of the left hemisphere were a trifle more prominent than those on the right; but otherwise the appearance of the two halves of the brain was identical. The needle wound was discrete and there were no immediate gross meningeal changes about it (Fig. 3). This brain had therefore received 144 milligram hours of radiation.

Upon microscopic examination, a collection of polymorphonuclear and round cells were evident at the site of insertion of the needle and were localized to this area. The leptomeninges were slightly thickened immediately external to the needle tract but over a very limited area. The blood vessels of the left hemisphere were large and filled with blood cells. There was no apparent thickening of the endothelium of the vessels, but there was a thrombosis of many of the small vessels about the region of the needle tract. This thrombosis extended about 3 millimeters away from the border of the immediate lesion (Fig. 4). The tract of the needle was necrotic and hæmorrhagic. There was no evidence of fibroblastic infiltration of the lesion but numerous gitter cells filled with fat were present (Fig. 5). The gitter cells showed evidences of migrating to the vessels in the vicinity of the needle tract though few were present in the perivascular spaces. Demyelinization was distinctly limited to an area less than a millimeter distant from the needle tract. Within that zone many myelin sheaths still remained but were greatly swollen. The nerve cells in the immediate zone were slightly swollen and vacuolated. There was very little evidence of neuronophagia. At a distance of 2 millimeters from the needle tract all the architectonic structure of the cortex was normal, with the exception of thrombosed small blood vessels as has been mentioned.

Fig. 7. Photograph of Dog Ra No. 4. Four milligrams of radium have been implanted in the cortex and allowed to remain for a total irradiation of 576 hours. They were then removed. This photograph was taken on the one hundred fiftieth day. X-ray plate of skull of Dog Ra No. 4 shows the radium needles in place.

The brain of Cat Ra No. 8 showed the same type of changes after 216 milligram hours of exposure. The area of demyelinization was well limited about the needle tract but not as closely as in those brains with smaller exposures. In the Cresyl-violet stained sections there was a complete absence of nerve cells in the zone of destruction with only a few, scattered, greatly swollen cells remaining with barely discernible nuclei. The cytoplasm in those cells was vacuolated and the processes were absent. The Nissl granules were absent. In the area just external to the zone of destruction, the cells showed a similar appearance. The inner zone measured about 4 millimeters in width; and the outer, 2. There was a moderate increase of glial elements. The transition to the normal cortex occurred within 6 to 8 millimeters from the needle tract (Fig. 6).

As has been stated, in a second series of animals 4 milligrams of radium were implanted for as many as 216 hours, and after the needles were removed the animals were allowed to live from 2 to 168 days. In Dog Ra No. 4, for example, four 1 milligram needles of radium were implanted and allowed to remain for a total irradiation of 576 hours and then removed. The animal was allowed to live for 150 days and remained in excellent condition throughout (Fig. 7).

In the area of the needle tract in this animal's brain, there was an increase in fibrous tissue which had grown in to fill the defect. Small collagen fibers passed directly from the leptomeninges into the brain (Fig. 8). In the Weil stain, the destruction and demyelinization of the myelin sheaths was limited sharply to the edge of the needle tract and there was no residual swelling of the myelin sheaths at the edge of the lesion (Fig. 9). The nerve cells in the region of the tract were smaller than normal so that the nucleus appeared out of proportion to the cell body. The cytoplasm of some of these cells stained darkly, while in others it barely stained at all. The Nissl granules were not well defined in either type of cell. In those nerve cells with lightly stained cytoplasm the processes had broken up and were retracted, while in those with a heavily stained cytoplasm the processes could be seen clearly. Neuronophagia was noted with from 4 to 8 cells about each nerve cell (Fig. 10). Astrocytes and oligodendroglia both were present but the latter predominated (Fig. 11). The gitter cells, which were so prominent in the brains of those animals which were sacrificed immediately upon removal of the radium, were absent except for an occasional one about a blood vessel. The microglia were not present in any greater number than is normal. These microscopic changes gradually faded away until at a distance of 1 centimeter from the needle tract the normal architectonic structure of the brain was present.

SUMMARY

In summary, then, the pathological changes consisted of a central zone of destruction immediately in the tract of the needle wound

Fig. 8.

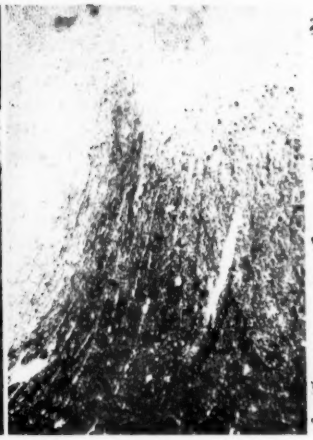

Fig. 9.

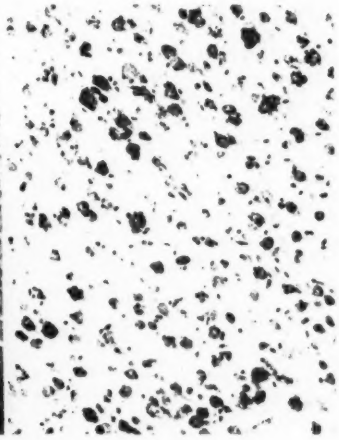

Fig. 10.

Fig. 8. Photomicrograph which shows the presence of small collagen fibers which pass directly from the leptomeninges into the brain in Dog Ra No. 4. (Van Gieson stain.)

Fig. 9. Photomicrograph showing destruction of myelin sheaths which was limited sharply to the edge of the needle tract. (Weil stain.)

Fig. 10. Photomicrograph showing neuronophagia with 4 to 8 cells in Dog Ra No. 4. These changes occurred within 4 millimeters of the needle tract. (Cresyl-violet stain.)

In the brains of those animals killed at the end of the period of exposure, gitter cells loaded with fat, thickening of the blood vessel endothelium with thrombosis of smaller vessels, amyelinization, and slight chromatolytic changes in the nerve cells were the prominent features. In the brains of those animals in which some reparative processes had time to occur, the gitter cells had disappeared, astrocytes and oligodendroglia cells were present in large numbers, and neuronophagia was present. The important fact to be recognized is that all of these pathological changes gradually faded away to the normal within the radius of a centimeter from the central zone of destruction.

CLINICAL EXPERIENCES

Thus far our clinical experience in the use of radium needles implanted within the brain is limited to one case and therefore this portion of our work is in the nature of a preliminary report.

Our primary object was to determine first of all whether or not the use of radium element implanted in the brain according to the technique we have described would produce damage to the surrounding normal brain structure. When it appeared that irreparable damage did not occur we felt justified in using it in an intracranial glioma. We believe that the case herewith reported was a severe test of the practicability of its use and that its future employment in these extensive gliomata should not be discouraged by the final result in this patient.

Headaches, vomiting, mental changes, convulsive seizures of 8 weeks' duration—verified glioblastoma of left temporal lobe—osteoplastic craniotomy—implantation of eight 2 milligram radium needles—2,688 milligram hours exposure—death 2 months later.

W. M., aged 14 years, Michael Reese Hospital B48570.

In February of 1932, the patient began to complain of severe headaches accompanied by vomiting. His memory was very poor and his mother stated that he acted queerly and became very difficult to manage. When he attempted to walk he became very unsteady and often fell to the floor unconscious. He would become rigid and then would have generalized clonic movements accompanied by incontinence.

Examination. The skull was large but there was no tympanitic note upon percussion. The left pupil was larger than the right and did not react to light. The right palpebral fissure was wider than the left. There was a high grade bilateral papilloedema with retinal hæmorrhages. The right side of the face was weaker than the left and there was marked weakness in the right upper extremity. There was a pro-

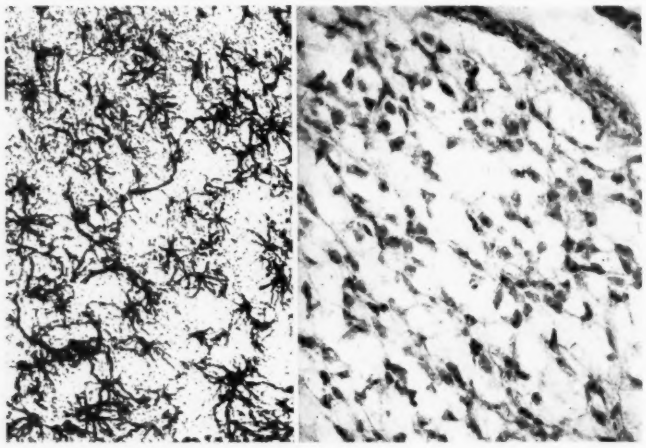

Fig. 11, left. Photomicrograph to show predominance of astrocytes immediately about the needle tract. (Cajal gold stain.)

Fig. 12. Photomicrograph of tumor removed from patient. This is a glioblastoma.

nounced ptosis of the left upper eyelid with difficulty in moving the left eyeball to the midline. There were no sensory changes. The boy had no aphasia, apraxia, or astereognosis. His visual fields could not be determined accurately because of his mental instability. His attention could not be held and his emotional outbursts were frequent.

Operation. It was many weeks before an operative permit could be obtained from his parents. On April 8, 1932, a left osteoplastic craniotomy was performed. The child had become stuporous and had to be fed artificially.

One and one-half centimeters below the surface of the temporal lobe near its anterior pole, a large, soft, gelatinous, reddish-yellow tumor mass was found. In areas it was firm but for the most part the tumor was quite soft and jelly-like. The cortical cap was removed with an electrosurgical unit and a portion of the tumor was removed by a curette and a sucker. Microscopically, it was a glioblastoma (Fig. 12).

Eight 2 milligram radium needles were implanted into the tumor mass at intervals of about 1 centimeter. The dura mater was left open over the temporal lobe and the bone flap was removed (Fig. 13).

Course. The immediate postoperative condition was precarious but after 12 hours his blood pressure rose to 90/50 and he was taking fluids by mouth. His temperature was 103.6 rectally and his pulse 150. Œdema of the left eye and face began. He talked and moved his right arm and leg as well as he had previously. Within 24 hours the œdema of his face had increased but he was more alert and his blood pressure was 128/78; pulse, 120; and temperature, 98.4. His recovery then progressed rapidly so that within 48 hours after operation the œdema had disappeared entirely.

Operation. On April 15, 1932, after he had received 2,688 milligram hours of radium exposure, the flap was elevated and the radium removed.

Course. The patient's recovery was excellent. The wound healed well, except for a slight necrosis of its anterior limb, which eventually disappeared (Fig. 14). His mentality became greatly improved and he was allowed to be about his ward unrestrained.

Six weeks after the removal of the radium his hair began to disappear and he became bald over the left side of his scalp.

On June 2, the patient became drowsy and hypertonic intravenous solutions did not produce any change in his condition. He gradually failed and died on June 11, 1932.

At the outset it was quite apparent that we were dealing with an extensive lesion, which had grown rapidly toward the midline, as well as into the frontal lobe. He became somnolent and unresponsive, a state from which he could not be aroused by hypertonic solutions. Although the final result may have been so different, it was not until his parents saw him in this moribund state that they consented to operation.

The postoperative œdema about this boy's face and left eye was more marked than we have ever seen following a craniotomy. It did not include the scalp over the bone flap and we are inclined to believe that it was due to an unusual circulatory stasis rather than to

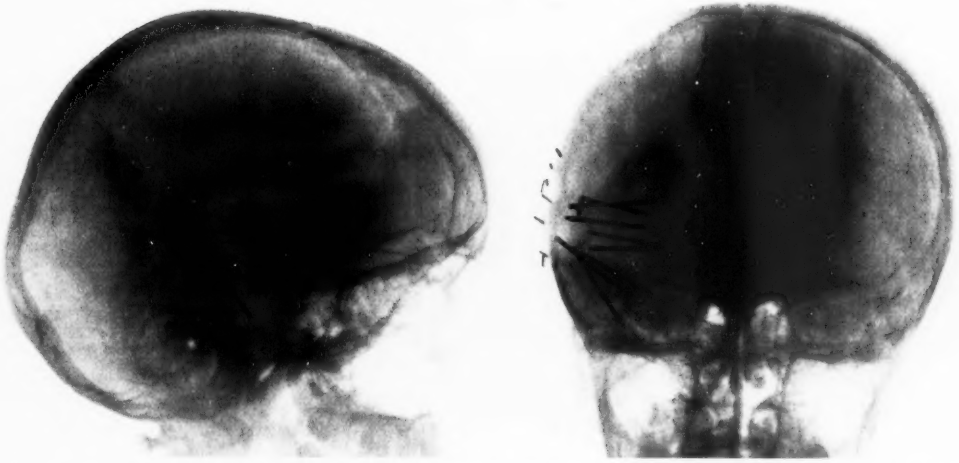

Fig. 13. X-ray plates of skull to show position of eight 2 milligram radium needles implanted into the tumor of the patient. Small silver clips are to be seen on the blood vessels of the cortex.

any direct effect from the radium. He did not have an unusual postoperative rise in intracranial tension which might have been due to œdema produced by the radium. Disappearance of the hair over the left side of the scalp was a late effect which was expected. The area of depilated scalp was considerably larger than the circumference of the area in which the needles were implanted.

We have no way of knowing accurately the duration and exact time of onset of the symptoms in this patient because of the inaccuracy of the history. The microscopic picture of the tumor, which was classified as a glioblastoma, led us to believe that the prognosis following operation would be unfavorable, since it is known that the clinical course of the glioblastomata is shorter than other tumors of the glioma group. These large succulent tumors produce tremendous œdema and intracranial tension. They grow rapidly, often extending throughout both cerebral hemispheres. They have been proved to be little influenced by X-ray therapy or by radical surgical operative procedures.

It is more than unfortunate that an autopsy permit was not granted because it leaves unanswered the important questions of the exact extent of the tumor and the effect of the radium upon the remaining tumor tissue and the surrounding normal brain. These are matters for future study.

We may be certain, however, that the implantation of radium needles and their subsequent removal is a practical procedure the success of which may be influenced by the care which is taken in the closure of the craniotomy wound.

DISCUSSION

The direct effect of radium upon tumor tissue has been investigated many times and though we wish to record our observations

Fig. 14. Photograph of patient 14 days after removal of radium needles.

upon this point as our experience increases it is not the primary point with which we are now concerned. Our aims were to establish whether or not radium could be placed within the brain for long periods without a fatality to the patient and without serious damage to the surrounding brain structure. Our experimental evidence and meager clinical experience would lead us to believe that radium implantation into the brain in small doses, properly filtered, and left for many hours is tolerated extremely well by animals and by man. This is particularly true if an adequate decompression is made to provide for any possible rise in intracranial tension.

Though a destruction of brain tissue occurred about the margins of an intracranial tumor, we would sacrifice it gladly for the advantages of treating such a tumor more adequately than we are able to do at present. However, we believe that such a destruction of cerebral tissue does not occur; certainly not beyond a radius of 1 centimeter. This means, therefore, that we believe that many of the pathological findings we have described may have been due alone to the introduction of a blunt needle into the brain. It has been shown by Penfield (17) that about the track of a blunt needle, compound granular corpuscles occur in larger numbers; that the astrocytes send in large expansions concentrically and in general a cicatrix results which contains connective tissue and causes gliosis and a distortion of the brain. Our results, therefore, are in accord with those of earlier investigators in that they show that radium in the doses which have been used does not materially injure normal brain tissue.

The tendency for radium and X-ray therapy to increase the capillary supply of the area treated was a question which arose during the investigation. We concluded that the pial vessels of the cortex were not increased in size or number and that we could discount the possibility of the development of a telangiectasis. Finally, there was no microscopic evidence of an increased vascularity, nor was there in any instance a tendency for secondary hæmorrhage to occur.

In none of the animals and in the single clinical experience there was no disturbance of the heat regulation mechanism. Though the needles were in many instances close to the ventricular walls, there was no destruction of the wall and no ventricular hæmorrhages occurred.

It must be remembered that some of the gliomata have a more embryonic structure than others; further, that the clinical course of some of them is longer before and after operation than others. The general experience of neurological surgeons with deep roentgen-ray therapy is in accordance with these two facts, though an exact law of behavior of the tumors to radiation is not possible. We have no doubt that such may prove to be the case with the use of radium. It is unlikely that the astrocytomata or oligodendrogliomata, which have a relatively slow clinical course, will be affected greatly. However, it is the outlying and peripheral extensions of these tumors, which are in more active cellular division, which we wish to inactivate by the implantation of radium needles. It is probable that a much larger initial dosage will be required for the glioblastoma group, an example of which we have reported upon.

CONCLUSIONS

1. The ideal form of radium therapy by implantation of needles is that which makes use of multiple weak radium foci adequately filtered and uniformly distributed over a period of 120 to 168 hours.

2. Radium element implanted into the brains of animals under such conditions produces no destruction of normal brain tissue.

3. It is surgically practicable to implant radium needles in a brain tumor, and remove them after the period of radiation.

We wish to express our thanks to Mr. E. H. Terwilliger for his help in preparing the microscopic sections.

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SOME PRINCIPLES INVOLVED IN THE PATHOLOGY AND TREATMENT OF EMPYEMA THORACIS

With Particular Reference to Treatment by Periodic Aspiration or Evacuation, with Air Replacement, Without Drainage[1]

JOSEPH A. DANNA, M.D., Ph.D., F.A.C.S., New Orleans, Louisiana
Professor of Surgery, Graduate School of Medicine, Louisiana State University Medical Center; Senior Surgeon, Hotel Dieu; Senior Surgeon, Charity Hospital

THE pathology of empyema differs in only one respect from the pathology of infection of the peritoneum or any other endothelial cavity, namely, in that pus forms in an area in which negative pressure exists. Whereas, in the abdomen a simple incision into the cavity and sufficient drainage to permit all the products of the suppurative process to escape are usually sufficient for the establishment of a cure, in empyema the presence of negative pressure complicates the mechanism of healing, the cavity having a tendency to pull apart and stay open rather than to collapse.

The pleural cavity may be infected in one of three ways:

1. By the direct introduction of contaminated material through a wound, including an operative wound.

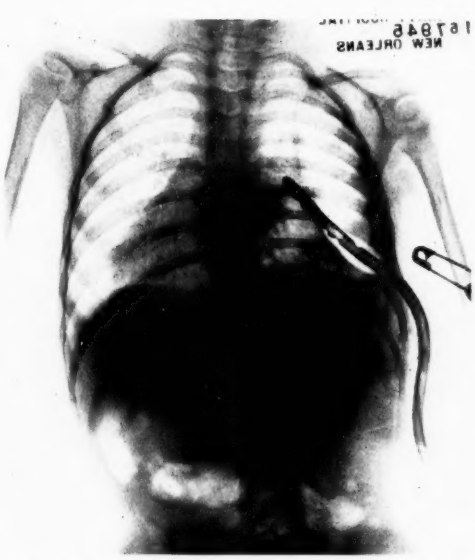
2. Through the blood stream. This is very rare, for even when blood stream infection does occur it usually involves infection of the subjacent tissues before the endothelial lining itself is infected, so it is not a direct blood stream infection of the pleural cavity.

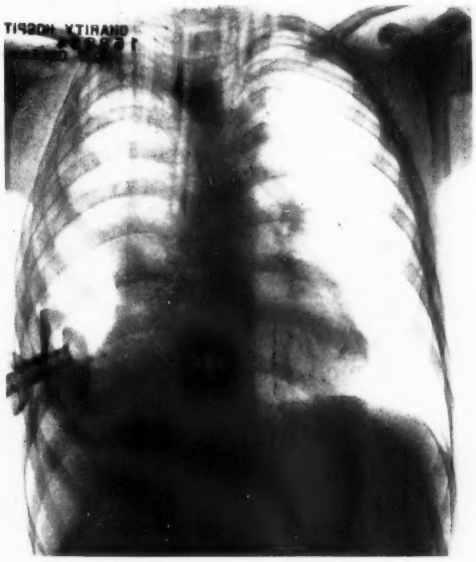
3. By the spread of infection from an adjacent organ or tissue. This is the usual mode of infection and may occur: first, by the spread, as in pneumonia or influenza, of an inflammatory process from the lung substance onto the endothelial surface; second, by the rupture of a cortical abscess of the lung which may either be so minute as hardly to leave any signs detectable at autopsy, or it may be so large that the sudden pouring of its toxic contents into the pleura, especially if no adhesions exist, may cause profound shock and even perhaps death before any surgical procedure can be instituted. There may be any grade of severity between these two extremes. Again, the pleura may be infected by the rupture of a subphrenic or liver abscess through the diaphragm, of a chest wall abscess through the parietal pleura, an œsophageal lesion through the mediastinal pleura, by the rupture or spread of a suppurative process in osteomyelitis of the ribs, of a similar lesion of a vertebra, or by the spread of infection from a purulent pericarditis.

A single pocket of pus will form if the focus of infection is a single one, the inflammatory process a slow one, the bacterial infection not highly virulent, and if it is situated in an area where there is little motion, as in the upper portion of the chest, in an interlobar space or in the immediate neighborhood of an adherent area. These conditions permit sufficient time to elapse for the formation of adhesions. This pocket will be small at first, containing little fibrin. It will grow gradually in size, and if not incised or drained or otherwise emptied, will finally overcome the cohesive force of fresh adhesions and rupture into and involve the entire pleural cavity, giving rise to symptoms of shock and toxæmia as in the rupture of a lung abscess. Where, however, the surrounding adhesions are very firm, a rupture may take place through the lung parenchyma into a bronchus and be drained partially in this way. More rarely, it may break through the parietal pleura into the tissues of the chest wall and finally point on the surface, or similarly invade the pericardium or subphrenic area.

If the focus is situated in an area where the lung moves widely and freely, or if there are a number of scattered small foci, or infected material is poured rapidly or in any great quantity into the pleural cavity, and if the infecting organism be of a highly virulent type, giving no time for the formation of protective adhesions, then the entire pleural cavity on that side will become involved as one large abscess cavity. This is the type usually

[1]From the Department of Surgery, Louisiana State University Medical Center; and from the Surgical Service, Hotel Dieu and Charity Hospital. Presented before the Clinical Congress of the American College of Surgeons, St. Louis, October 17–21, 1932.





Figs. 1 and 2. Drainage tubes of different variety in place, and cavity in each case entirely empty of pus and filled with air.

seen as a complication of influenzal pneumonia. As the purulent fluid increases in quantity, the lung gradually collapses, and finally the heart and mediastinum may be pushed over toward the unaffected side. These large cavities may contain large masses of fibrin both adherent to the walls and floating in the fluid.

If a cortical abscess no matter how small, communicating with a bronchus, should rupture into the free pleural cavity, a bronchial fistula will result. Reinfection of the cavity will continue till the fistula closes, and air may be forced into the cavity at each effort at coughing or straining, adding a spontaneous pneumothorax to the empyema, the combination being known as pyopneumothorax. This latter condition occurs more frequently in children, and following gunshot or stab wounds of the lung in adults. It presents the added danger of a possible tension pneumothorax which, especially in children, may increase to the point of pushing the heart and mediastinum over so far as not only to diminish the actual breathing capacity to a point dangerous to life, but also to interfere with the circulation by pressure on the venæ cavæ and innominate veins, thereby preventing the ready filling of the right heart. This danger is to be constantly remembered in treating empyema by any truly closed method.

No matter what treatment is instituted, the empyema will persist and pus continue to re-

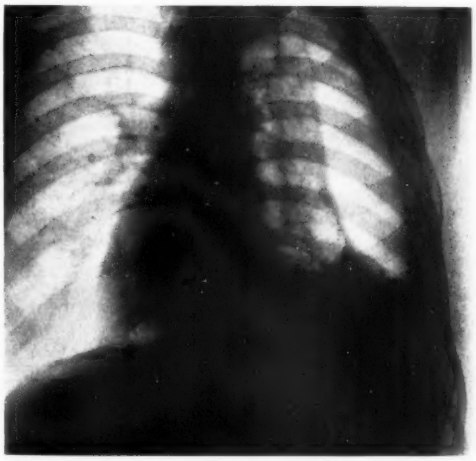


Fig. 3. Similar pneumothorax cavity in a third patient, immediately after drainage tube was removed and patient considered clinically cured.

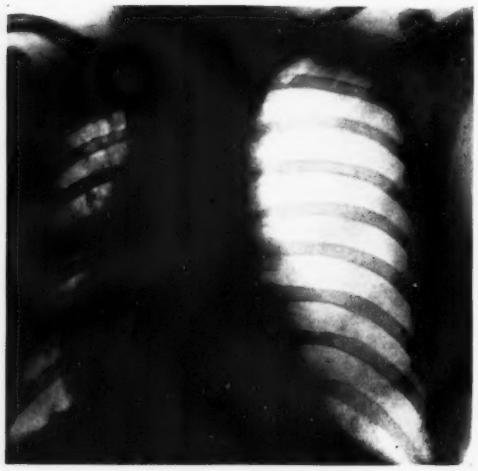


Fig. 4.

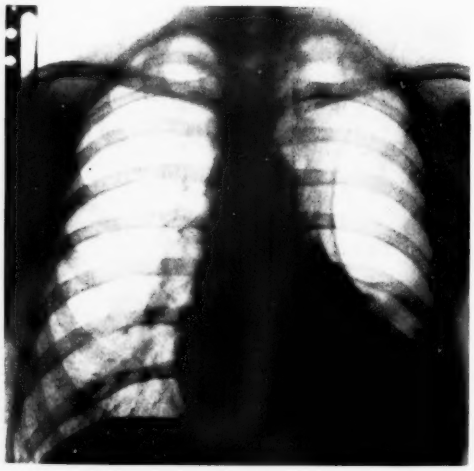


Fig. 5.

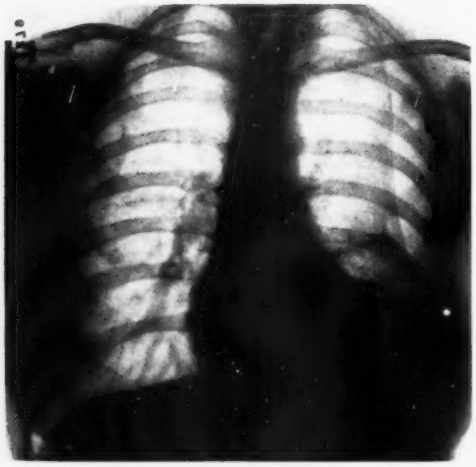


Fig. 6.

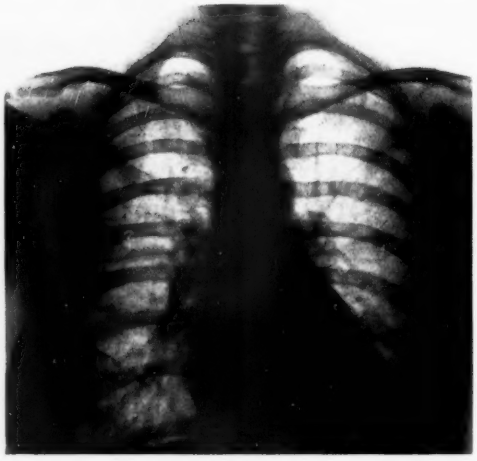


Fig. 7.

Figs. 4, 5, 6, and 7. Various steps in air absorption and lung expansion in a patient treated by aspiration and air replacement. Figure 4 shows practically the same condition as Figure 3. Note the diminution of density of the lung in Figures 5 and 6 as air is absorbed and the lung expands.

form until the source or focus of infection has ceased to pour infected material, as it were, into the pleural cavity. Thus bronchial fistulæ and communications with a lung cavity or with any other infected area must close before the suppurative process can stop. Long continued bronchial fistula, or other persistent sinus opening into the empyema cavity is the most frequent cause of chronic empyema.

As brought out by Graham (9), a large empyemic accumulation involving more or less of the entire hemithorax even with virulent organisms may not very materially immediately endanger the patient's life if both lungs are otherwise comparatively normal.

But in the presence of any pathology which curtails the function of either lung and especially of the lung on the opposite side, par-

ticularly if associated with the usual additional toxæmia and exhaustion of a patient who is very sick from an acute pneumonic condition, then even a very small empyemic accumulation may prove to be a very serious complication. Thus in pneumococcal empyema which develops after the subsidence of the acute pneumonic process, the condition is not nearly so serious as in influenzal empyema, which usually develops during the progress of the acute influenzal process in the lung. The virulence of the bacteria present also influences the severity of the case.

HEALING OF THE EMPYEMA CAVITY

How does an empyema cavity heal? A *small* cavity may perhaps heal by granulation and cicatricial approximation of the separated pleural surfaces. It is difficult to conceive, however, that a cavity as large as half the chest cavity could possibly heal in this way. *Large* cavities diminish in size only to a very limited extent as a result of granulation and cicatrization. The main mechanism of healing after reinfection has ceased is by:

1. Sealing of the cavity from the outside, resulting in a closed pneumothorax;
2. Gradual absorption of the remaining air, the lung being drawn out by the resulting increase in negative pressure until all air has finally been absorbed, when the cavity is obliterated.

In these larger sized cavities, when all pus and all dead material, including fibrin, clots, necrotic tissue, etc., have been removed, or drained out, and the cavity ceases to be reinfected from within or without, pus practically ceases to re-form. So far as the walls of the cavity are concerned, the condition is now analogous to the clean granulating surface of an abscess after all necrotic material has been cleared out. This is equally true whether drainage has been used or the contents have been removed by needle or otherwise. At this stage the infecting bacteria no longer float in a lake of pus, which is a most favorable culture medium, but lie in contact with and hence at the mercy of the activated fixed tissue cells, which now amply care for what contact bacterial infection is left on its surface. Thus the cavity becomes practically sterile soon after it is freed of all fluid and dead and extraneous material. The ability of an endothelial surface to care for a certain amount of bacterial contact infection is familiar to laboratory workers, who find it difficult to infect an endothelial cavity. Graham (8) found it very difficult to produce empyema in experimental animals by introducing even large quantities of bacterial laboratory cultures. The abdominal surgeon does not fear peritoneal contact with infected material if no gross fluid or solid matter remains, and usually feels safe if he can wipe the contaminated surface clean.

To get back to our subject, we now have a clean cavity filled with air. The drainage tube, if any, may at this stage be surrounded by granulations and adhesions which shut it off from the cavity. In any event it traverses an area of greater or lesser depth of clean healthy granulations which will readily come together with rapid closure of the drainage sinus if the tube is now removed. Bacterial counts in smears taken from the wound are a valuable aid in determining the optimum moment for removal of the tube, though one can usually judge by the quantity and quality of drainage. A roentgenogram taken at this time will show a pneumothorax cavity of approximately the size of the original empyema cavity (Figs. 1, 2, 3). Identically the same picture is shown when aspiration and air replacement has been used (Fig. 4). The cavity now, sealed from the outside, gradually diminishes in size as the contained air is gradually absorbed, and is finally completely obliterated, as can be shown by repeated roentgenograms (Figs. 4, 5, 6, 7).

The impression seems to be general that these cavities fill from the bottom, as evidenced by the fact that the cavity will hold less and less irrigating fluid. Whatever may be the explanation of this phenomenon, the fact remains that it cannot be generally so, for if frequent roentgenograms are taken, no filling in of the cavity by granulations is evident, and comparatively little diminution in the size of the cavity in the drainage cases takes place until the drainage sinus closes. After this the lung can be seen gradually expanding and approaching the chest wall.

During this process its shadow becomes not denser, as it would if to the lung shadow were added the shadow of superimposed new granulations, but less dense owing to thinning of the lung substance as a result of its expansion and filling with air from within.

Some granulation and cicatrization does occur, however, not only around the tube, but also in the angles of the cavity so that the cavity in this way grows somewhat smaller. If the process is of long standing, continued inflammatory infiltration renders the lung surface more and more hard and unyielding, its edges become firmly bound to the chest wall, diaphragm, or mediastinum, and there results the type of chronic empyema which is due to inability of the lung to expand as the air is absorbed.

In every case when healing has taken place and all air has been absorbed, the pleural surfaces are finally glued together over a greater or less area by firm organized adhesions. Where tube drainage has been used, the adhesions are more pronounced and cover a larger area. In fact, the opinion prevails that in all cases the entire surface involved becomes permanently adherent. An experience with two patients with pyarthrosis of the knee who were treated by aspiration and air replacement and who are well with practically no impairment of movement, makes me lean very strongly to the opinion of Forlanini, that it may be possible, if little trauma is inflicted on the pleura by treatment, to have the endothelial surfaces at least over a greater or less area, finally free of adhesions. We know that this is so in the peritoneal cavity. True, the frequency with which pleural adhesions are encountered at autopsy in patients never known to have had any such serious pathology as empyema may be cited as evidence that things are different in the pleura. But the question will bear consideration and investigation. I believe it not only possible but probable that, in many cases treated by aspiration and air replacement, during the period of 2 or 3 weeks or more required for complete air absorption that follows clinical cure, the endothelial surfaces may revert to normal and glide freely over each other when they do come in contact.

I may say a word at this point as to the use of antiseptic washings. There should be no more need or indication for them here than in the peritoneal cavity or elsewhere. Most other abscesses do better without antiseptic washes or interference of any kind. Against this, however, stands out the remarkable improvement and shortening of convalescence which followed the introduction of irrigation with Dakin's solution during the World War. This irrigation is still very popular and quite generally used. The solution, it is said, will cause the fibrinous masses to dissolve and drain out. If this is desired, I wonder if papain (11, 16) or some other digestant would not be more effective.

That the fibrin will liquefy, is attested by the many cases of empyema that have during these recent years gotten well by the use of small catheter drainage, and by some form of aspiration, in the greater number of which no irrigation has been used. For, as experience with rib resection and open tube drainage has taught, most patients have fibrinous masses that could not pass through a needle or small catheter. These masses, therefore, must have been reduced to a state in which they would pass through a small catheter or aspirating needle.

DIAGNOSIS

The early diagnosis of empyema is not always easy. In cases in which a known hæmothorax or marked serous effusion is infected and becomes purulent, this may be readily determined by exploratory puncture. This is not, however, the usual way in which the largest number of empyema cases in civil practice begin. They usually start as a small intrapleural accumulation temporarily walled off by adhesions. This may be situated in any region of the chest cavity. If treatment is instituted in this early stage, one has to deal with only a small accumulation. If the case, however, is not recognized early and no active treatment has been instituted, the adhesions are finally overcome and more or less of the entire pleural cavity will be involved. The localization of a small accumulation is often very difficult. If deeply situated, physical examination may reveal nothing abnormal. If near the surface, there will be dullness and

diminished or even absent breath and voice sounds. Next to the finding of pus by needle puncture, roentgenography is the most valuable single means of diagnosis. It has, however, all the possibilities of error inherent in the interpretation of shadows. When pus is found, the localization and outline of the cavity may be very much facilitated by removing as much pus as possible even though a small quantity and replacing this pus with air. Roentgenograms now taken with the patient in a number of different positions and with the rays directed *horizontally* will show a fluid line with air above so that it is possible by a study of a series of views to outline definitely the entire cavity. If the cavity has been completely emptied of fluid with air replacement, it will stand out clearly in the roentgenogram in any one position.

One should never be satisfied that pus is not present because of a single negative exploratory puncture, and the largest possible needle should be used, for very thick pus will not flow through the usual aspirating needle. There may be two or more separate noncommunicating cavities, each of which will require separate treatment. A small empyema pocket may be situated deeply in an interlobar area, or over the dome of the diaphragm, or between the lung and pericardium or mediastinum, so that healthy pleura or lung must be traversed in order to reach it. In such cases the course is to all intents and purposes like that in a lung abscess. In their drainage, open or closed, one may cause infection of the general pleura or injury to the lung substance. It is sometimes very difficult to distinguish between an abscess and an empyema cavity. Here one's clinical sense must come to his aid. A patient with a lung abscess is usually much more seriously ill than one with an empyema cavity of equal size. If the abscess is cortical, and adhesions exist, there is usually no serious danger in inserting a needle into it. One will meet, however, the occasional foul-smelling anaerobic lung abscess, the puncture of which may result in an acute phlegmonous infection of the chest wall with the most serious consequences.

I have said nothing about pathognomonic physical signs of fluid in the chest. Areas of dullness in empyema do not change with position as has been taught, even in large effusions, unless a considerable quantity of air is present, for the structures which surround an empyema cavity very early become fixed, so that the lung cannot shift position in different postures.

PROPHYLAXIS

Can we do anything to prevent empyema? Children with whooping cough or other pulmonary conditions, who have violent repeated spells of coughing, should be given such remedies as will minimize the violence of the efforts at coughing and thus avoid, if possible, the rupture of a cortical lesion and the production of spontaneous pneumothorax which may occur even without any lung pathology. Chest wall infections should be incised early. The same is true of liver and subphrenic infections. In making an exploratory puncture or in aspirating a serous effusion one should observe every aseptic precaution so as not to convert a serous into a purulent effusion. All effusions should be evacuated. Especially is this true of hæmothorax. The chest should be emptied of blood just as soon as sufficient time has elapsed to make one reasonably sure that the hæmorrhage will not recur. If the blood or serum is replaced with air, every drop of fluid can be withdrawn without altering the intrapleural tension. In fact, as brought out by Morelli, to prevent recurrence of hæmorrhage or even to arrest it if persistent, a larger amount of air may be injected than the fluid removed, to the point of producing positive pressure if necessary. As the air during the ensuing 2 or 3 weeks is gradually absorbed the lung will gradually expand. Patients with chest lesions, whether inflammatory or traumatic, should be the object of solicitous care and should be frequently visited and examined by the physician or surgeon and frequent roentgenograms should be taken.

TREATMENT

Three methods of treatment of empyema are now in vogue. First, incision and open drainage with or without rib resection and with or without irrigation of the cavity. A

large rubber tube is the most generally used means of drainage. Some go so far as to advocate gauze packing of the entire cavity (2). Second, closed tube drainage, a large catheter or similar tube being inserted through a small stab wound or by means of a trocar, the tube being intended to fit so tightly that there is no leakage between it and the surrounding chest wall. Some form of suction more or less continuous, and some form of irrigation is the rule. Third, aspiration.

I shall also discuss a fourth—periodic aspiration or evacuation of the pus, with air replacement, and without drainage.

Incision with or without rib resection, and open drainage. This was the method generally in use until the outbreak of the World War. During the measles and influenza epidemics, the reports from the various Army hospitals in the United States to the Surgeon General's office showed the death rate from empyema after open operation to average 30 per cent in some hospitals and in others to run as high as 70 per cent. The Empyema Commission (20) found the highest mortality in the hospitals in which open drainage was instituted as soon as an effusion became purulent or pus was located. Evarts A. Graham (9), a member of the Commission, carried out experiments showing the manner in which a large opening in the chest wall endangered life, the danger being proportionate to the size of the opening. He showed that in the prevalent type of streptococcic infection, the empyema developed while the lung condition was at its height, and not after its subsidence, as in the pneumococcal type. He also showed that open thoracotomy could be done with a greater margin of safety later, when the mediastinum became rigid as a result of inflammatory infiltration, so that the disturbance of equilibrium incident to operation could not be transmitted to the lung and pleura of the other side.

The result was deferred operation. Temporary aspiration was done as indicated, and some patients were cured by this aspiration alone. When operation was done later, openings only large enough to insert a tube were made and even the tube was protected by dressings or some special valve-effect appliance and its caliber diminished by smaller tubes inserted for irrigation with Dakin's solution. This solution seemed to sterilize the cavity, dissolve the fibrinous masses, and shorten the period of convalescence. Repeated wound cultures were taken and when the secretions were sterile or the bacterial count in smears from the wound reached a very low figure, the tube was removed. Treatment was more or less standardized along these lines, and a marked reduction in the mortality rate resulted.

As compared with other methods, open drainage has the following advantages: (1) The surgeon has the satisfaction of looking into the cavity, or removing a few large fibrinous flakes, and even of putting his finger into the recesses of the cavity. (2) In most instances, unless there is later delay in healing, the surgeon is through with his work when the operation is finished and the patient has rallied from any resulting shock. No close, repeated personal observation is required on his part if convalescence is normal. In a large number of cases the patient may get well without his having seen him again, ample care being given him by the nurse. (3) Irrigation can be done if desired. (4) Tension pneumothorax is impossible. (5) Foreign bodies can be removed.

On the other hand: (1) there is always shock of varying degree, depending upon the degree of rigidity of the mediastinum, the amount of lung disease present, and the care used in minimizing the effects of open pneumothorax by hand or gauze closure of the wound during the operative procedure, valvular closure of drainage tube, etc. (2) There is much secretion and drainage, requiring frequent abundant dressings, the patient being more or less constantly soaked in fetid pus, and therefore a nuisance to those about him. (3) The tube may not be placed so as readily to drain the cavity, and a second thoracotomy may be required. In this connection, many surgical textbooks describe the exact spot on the chest wall at which a thoracotomy should be done. I heard a very able surgeon who holds a high hospital and teaching position recently say he always resects the sixth rib in the posterior axillary line. Those who practice such a set rule will strike an empyema

cavity in most instances, if the entire pleura is involved. I should have missed it in nearly half of my own series of cases. Evidently, these men very seldom see empyema in the early stages. Or do they drain at one spot and then find their way to the cavity by dissection, or separation of adhesions? (4) Occasionally a tube gets lost in the cavity with resultant embarrassment for the surgeon and trouble for the patient. (5) As a result of the presence of the tube, (a) some secondary infection is inevitable; (b) pressure contact may result in intercostal hæmorrhage; ulceration into a bronchus; much granulation about the tube, and if long continued, the formation of a thick walled sinus, with greater tendency to chronic empyema than by any other method. (6) There is always a deforming scar.

Closed drainage. As early as 1890 Forlanini reported 6 cases of empyema treated in the previous 2 years by this method. He recites a controversy at the Medical Congress in Vienna in 1889 between the advocates of wide open incision and drainage and the partisans of what he called the Bulau method, which is exactly the closed tube method as practiced today. He favored the latter, but said that complete emptying of the cavity was essential to a cure and the Bulau method did not remove all fluid at once. The fluid could only be removed by replacing it with air. He, therefore, by needle puncture or after introducing a Nélaton catheter through a trocar removed all fluid by repeated alternate suction of fluid and injection of air. He produced a negative pressure in the cavity by replacing the fluid with approximately one-half its volume of air. This negative pressure he maintained by a sealed two-bottle gravity method. He aimed at keeping the cavity free of pus and favoring closure of the cavity by constant suction. He also used repeated washings of the cavity mostly with boric acid solution. This, except for the complete emptying by air replacement, describes the present day method. In fact, there is much talk, to the contrary, of keeping air from entering so as to prevent pneumothorax. This is a misconception of the principle of avoiding a marked open pneumothorax which means a free opening which allows air easily alternately to enter and escape with each respiratory cycle. Forlanini's article would well repay reading by any one interested in this subject, for there is hardly any aspect of the pathology and treatment of empyema that he does not discuss, many of his terms being in the language of what is considered most up-to-date on the subject today. Morelli, Forlanini's pupil and successor, does a rib resection, inserts into the pleural cavity a *large* tube which traverses an hourglass inflatable balloon intended to give an air-tight fit, irrigates with clorosol, and maintains negative pressure (Fig. 12). This technique gave him excellent results in the treatment of fresh thoracic wounds.

Closed small tube drainage can be instituted without the shock incident to open drainage and without the dangers incident to an open pneumothorax. Irrigation of the cavity can be done if desired. Negative pressure can be maintained by some form of suction, this being by many considered desirable, as favoring earlier collapse of the cavity. Others encourage collapse by forceful blowing exercises against resistance. Forlanini used inhalation of air under pressure. I believe little is to be accomplished by any of these measures except in so far as they help to empty the cavity of pus. To the contrary, they may all have a tendency to favor the passage of fluid exudates from the lung into the cavity and to maintain or re-establish the patency of a bronchial fistula or infecting sinus.

As disadvantages of the method may be mentioned: (1) The small tube may be blocked by plugs of fibrin; (2) it may not completely drain the cavity; (3) the tube may not remain air-tight, air finally finding its way between it and the surrounding soft parts, favoring secondary infection; (4) to a lesser extent than in open tube drainage, granulations form about the tube and chronic empyema may ensue if drainage is of long duration; (5) possibility of tension pneumothorax.

Aspiration. As Forlanini well brought out, it is impossible to empty most empyema cavities completely of all fluid by aspiration alone. In fact, he divides them into three classes according to the degree to which the walls yield to suction: (1) in which the walls yield

Fig. 8. Making small stab wound to facilitate introduction of large needle.

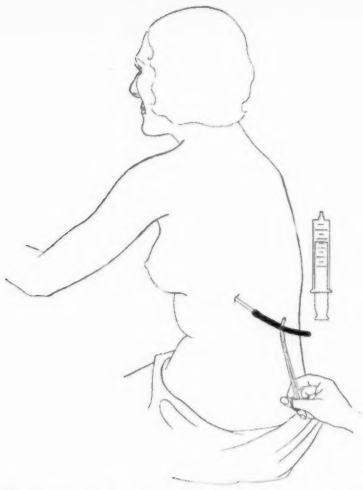


Fig. 9. Large needle attached to clamped rubber tubing and ready for connection to syringe. (First method of aspiration and air replacement.)

readily to aspiration; (2) in which the walls yield later to continued suction; (3) in which they never yield, and thoracoplasty has to be done to collapse the cavity.

The accidental or incidental cure of empyema by aspiration is as old as aspiration itself. During the World War experience more than 10 per cent of the cases were cured by the aspiration which was done as preliminary to later thoracotomy. But no one has ever definitely shown that any great number of consecutive cases can be cured by aspiration alone. Nor have I ever made such a claim. It may occasionally be possible to remove most of the pus in an empyema cavity by simple aspiration. I think, however, that this rarely takes place. What often happens is that during the course of the aspiration, air is permitted in some way to enter the cavity and that these cases are really being treated not by aspiration alone, but by aspiration and air replacement.

Air may find its way into the cavity: (1) by suction through the needle while disconnected from the syringe; (2) by needle puncture of the lung; (3) by tearing of the lung by the force of aspiration. I recently discussed a paper (13) by an eminent pediatrician on aspiration in the treatment of empyema, who stated that he had had no experience with aspiration and air replacement. I was able to show, by one of his own lantern slides, that he had, if accidentally and unknown to him, practiced air replacement, for he showed a cavity completely filled with air and completely empty of pus after one of his aspirations. Instances are on record (17, 19) where the pull of forceful aspiration tore the lung substance, producing a bronchial fistula and spontaneous pneumothorax and permitting free emptying of a cavity after previous repeated negative attempts. McEnery and Brennemann describe the incidence of pyopneumothorax after one or more aspirations and frankly attribute it to pulmonary trauma by the aspirating needle. They also cite an instance where a hypodermic needle used to give a cardiac injection of epinephrine perforated the thin leaf of left lung overlapping the heart, producing marked pneumothorax, and when at autopsy the lung was inflated through the trachea, air bubbled out through the opening made by the small needle.

Periodic aspiration or evacuation with air replacement, without drainage. Forlanini's article, already cited, describes a method of emptying completely the chest of fluid by aspiration and air replacement. He gives Parker credit for first suggesting it. This same method was described and credit given to

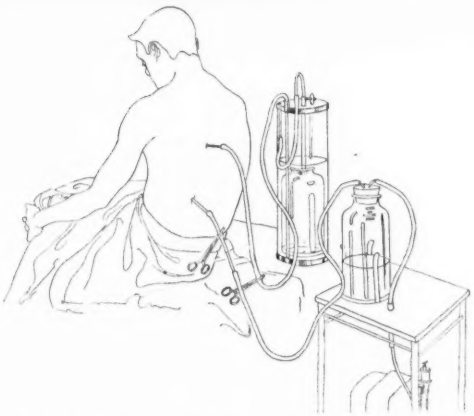


Fig. 10. Large needle connected to suction apparatus and smaller needle inserted higher up connected to pneumothorax apparatus, both controlled by forceps clamping. Glass tubing connection in lower tube near the needle end of the tube through which air bubbles can be watched for to determine when the cavity is empty of fluid. (Second method.)

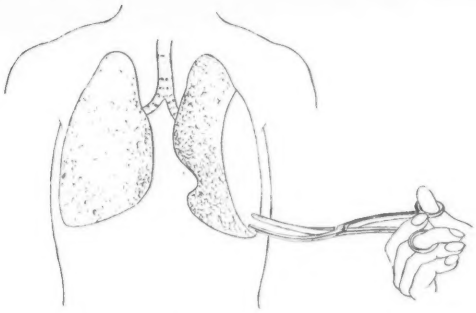


Fig. 11. Graphic demonstration of third method showing long forceps introduced through small stab wound permitting free flow of fluid outward and air inward and ready to grasp fibrinous masses that may present in wound.

Forlanini by Morelli, his pupil and successor, in a monograph on wounds of the chest, in 1918. While serving with U. S. Army base Hospital No. 102 on the Italian front a short distance from Morelli's Special Hospital for thoracic wounds I became acquainted with this method through the same monograph and for a number of years after had occasion to use it in the removal of non-purulent effusions.

If one tries to empty the chest of a fluid accumulation by simple aspiration with no air replacement, one eventually has to stop without removing all the fluid for one of two reasons: either the negative pressure becomes so great as to cause pain and respiratory or cardiac embarrassment, or the needle will come in contact with the visceral pleura and cause pain, coughing, dyspnœa, and shock. If, instead, the fluid is gradually replaced with air as it is removed, the cavity maintains its original size and shape, and every drop of the fluid can be removed with practically no discomfort.

It did not occur to me to use this method in the treatment of empyema until 1923, when I had occasion to perform a temporary aspiration on a young woman with an empyema complicating an influenzal pneumonia. Having found pus by exploratory puncture, I decided while the needle was still in place to remove as much pus as I could, previous experience with aspiration with air replacement of non-purulent effusions encouraging me in the belief that I should be able to do this without harm or discomfort to her. This I proceeded to do, easily removing 300 cubic centimeters of frank pus and replacing it with an equal volume of air. The patient improved remarkably immediately after this, and when a few days later I spoke of thoracotomy she suggested another aspiration which I did again, replacing the fluid with air, and finally did the same thing a third time. Following this the patient was clinically well and has been well since. Thus my initial case was accidental and unexpected.

Two years ago I reviewed (3) 35 consecutive cases treated by this method. I have had a few more since, and know of some 75 more treated by others in New Orleans and elsewhere. The patients have been of all ages, varying from a few months to 75 years, and of practically every variety of etiology and bacterial infection. I myself have had but 2 deaths, neither of which I believe was attributable to the treatment. I feel more and more with increasing experience that the method has much merit, and while it has its weak points and even its dangers, yet I believe it is applicable as generally as any other one method, and especially so in very sick patients. So that judiciously used it should

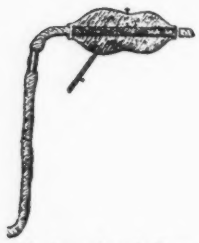


Fig. 12. Inflatable hourglass balloon of Morelli traversed by large drainage tube. Note smaller tube for inflation of balloon. These hourglass balloons are made in different sizes and inflated sufficiently to give an airtight fit without undue compression of tissue. The balloon and tube are removable, a smaller one being used as the opening gets smaller.

lower the mortality of any one doing a large volume of this work.

I should like to see it more generally used and especially advise the most skeptical to use it as a preliminary measure to their own pet method. Many I am sure will be surprised by the results.

It may be interesting here to remark that Forlanini tried to treat his first two cases by aspiration without result. He later used aspiration with air replacement, getting complete emptying of the cavity, and these first two cases were cured by this method. In the remaining cases he used it only as a preliminary measure, followed by closed tube drainage, and in his concluding remarks says that one should not lose time trying aspiration. I must also say that I was not familiar with these facts nor with the work of Elias until I looked up the literature in December, 1930, in the preparation of my paper published in 1931 (3).

TECHNIQUE

Three methods are used to remove the contents of the empyema cavity and replace it with air.

1. In small effusions, by puncture with a single large needle attached to a syringe.

2. In large effusions, by puncture with a large and a small needle to which a suction apparatus and a pneumothorax apparatus are respectively attached.

3. Where the needles become blocked, by temporary small intercostal incision with emptying of cavity by repeated forced inspiratory and expiratory effort.

In small effusions. The site and outline of the purulent effusion having been determined, a point in the intercostal space corresponding to the lowest point of the empyema cavity is anæsthetized with 0.5 or 1 per cent solution of procaine hydrochloride, all the tissues from skin to pleura, inclusive, being thoroughly infiltrated. A large needle is now attached by a *stiff rubber tube* connection to a 50 cubic centimeter Luer syringe and inserted at this point. A syringeful of pus is now aspirated, the tube is clamped with hæmostatic forceps, the syringe is disconnected, emptied, filled with an equal quantity of air and reconnected to the tube and needle, the forceps are unclamped, and the contained air is injected. This alternate aspiration of fluid and injection of air is repeated until, on aspiration, air comes through the needle, which shows that the needle point is now above the fluid line or that all fluid has been aspirated. The patient and needle are manipulated so as to make sure that the needle point rests in the bottom of the pus cavity, and the procedure is repeated until air again comes from the needle, which indicates that no more fluid remains. This is preferably done with the patient sitting up, but very sick patients are treated lying down with the head and shoulders slightly elevated. It is essential that the connecting rubber tubing be very stiff, as ordinary tubing will collapse with the amount of suction usually required when the pus is thick. The introduction of a large needle is much facilitated by making a small skin stab with a sharp pointed knife (Fig. 8). The needle attached to the clamped tubing may more conveniently be inserted before connecting with the syringe. (Fig. 9).

In large effusions. A second spot in the chest wall is infiltrated with the anæsthetic solution and a second smaller needle is introduced. The first larger needle is connected to the suction apparatus and the second needle to some form of pneumothorax apparatus whereby the amount of air that comes through can be measured, and the cavity rapidly emptied by simultaneous suction and air injection (Fig. 10).

When the aspirating needles are blocked. In some cases the fibrinous exudate prevents

complete emptying of the cavity by blocking even the largest needle, rendering it possible to aspirate, at most, only from one-half to two-thirds of the contained pus. If delay is inadvisable, a small intercostal incision is made, just large enough to introduce the index finger; the patient is turned so that this incision lies at the most dependent part of the cavity, and he is instructed to perform repeated forced inspiration and expiration while a long pair of forceps keeps the incision open (Fig. 11), fluid being forced out with each expiration and air forced in with each inspiration, masses of fibrin being removed by the same forceps as they appear in the wound, until the entire cavity is thoroughly emptied of fluid and free fibrinous masses. In children the crying efforts are utilized in the same way. If the patient becomes shocked or has a tendency to cough, the wound is closed by digital pressure and the patient is immediately relieved. After a moment the procedure is continued as before. When the chest has been entirely emptied, the patient takes a final deep inspiration, at the end of which the lips of the wound are compressed digitally and kept so by a gauze compress. These wounds do not drain; they heal readily and have to be reopened if the procedure is to be repeated.

This last method may perhaps more readily appeal to many who seem so unreasonably prejudiced against aspiration. They can have as bloody a field as desired, can see the pus pour out, including fibrinous masses, and can reopen the wound at will.

In many of these cases there seems to be no reason to hurry, and if one will have the patience to wait, the fibrin will eventually liquefy. I have been on the point of making an incision in a number of these patients, but after repeated aspirations, without using anything intended as a solvent, the contents finally became perfectly fluid and it was possible to empty the cavity entirely.

APPLICATION OF METHODS

Whichever of these three methods is used, the volume of air replaced is usually the same as that of the fluid removed. It may, however, be varied, as indicated. Thus, if the cavity is refilling very fast, so that more fluid accumulates than the volume of air absorbed in the same period, less air is replaced, and *vice versa*. Negative pressure, if desired, may be produced by injecting as little air as desired. I have never deemed it advisable to do so. The air *per se* has no therapeutic value. It is merely used (a) to render possible evacuation of all the fluid, and (b) to replace completely the fluid and support the walls of the cavity as before.

Thus the architecture of the cavity, as it were, is not altered, and the hydrostatic or rather the physical compression of the lung is undisturbed, except that the heavy inelastic fluid mass is replaced by a light elastic air cushion. In the many hundred times that I have introduced the largest available needles into the pleural cavity, I have never witnessed the clinical syndrome spoken of as pleural shock. I believe that this is due to the pains taken to infiltrate thoroughly not only the skin proper, but the pleura itself and all the intervening tissue with the anæsthetic solution. I have never used general anæsthesia. No drain, no suction or irrigation in any form is used.

The amount of pus removed may vary from a few cubic centimeters to as much as 3,000 cubic centimeters or more at one time. The procedure is repeated as often as the fluid accumulates, on an average of about every 6 days. The amount of reaccumulation between aspirations is seldom over 300 cubic centimeters and often less, quite in contrast to the large quantities seen when tube drainage is used. Patients leave the operating table feeling relieved and, having had no discomfort during the procedure except for the infiltration of the local anæsthetic, willingly and cheerfully submit to subsequent aspirations.

The cavity has a tendency to get somewhat smaller as the condition improves, partly because of granulation and cicatrization in the angles of the cavity, and partly perhaps because the air is absorbed faster than the fluid reaccumulates, so that one may find the diaphragm gradually rising, requiring insertion of the needle in a higher intercostal space at later sittings.

I believe that complete emptying of the cavity is essential to bringing about a cure.

One patient was cured with one aspiration. Some patients have had ten or more. The average has been about four. When the cavity has been entirely emptied, the patient's temperature drops to normal in a few hours and he feels greatly improved and is able to eat, sit up, and take an interest in things about him. If the aspiration or evacuation is not immediately followed by this improvement, it means that the cavity has not been emptied, or that the patient has another cavity or some other serious condition that is making him sick, and a diligent effort must be made to find it.

My second patient had three separate cavities, the roentgenograms taken after partial emptying showing three separate fluid lines. These cavities communicated with one another, and by rolling the patient first one way and then the other we were able to get the fluid from all cavities against one side of his chest wall and aspirate it. In some of these patients there are separate cavities that do not communicate with one another. In 1 case, after quite a large cavity had been evacuated and the pus replaced with air, the patient continued to have elevated temperature and to look sick. The roentgenograms showed a shadow, and aspiration revealed another cavity, above the one that had previously been emptied. This was treated the same way and she made an uninterrupted recovery. I have had 3 such cases, in 1 of which there were three separate cavities.

I have for some time adopted the practice of making a small stab in the skin at the site of needle puncture, and I believe that this is one reason why I so seldom see a local pustule or abscess following exploration or aspiration. This little stab wound makes possible the introduction of the large needle which one must use without the pain and psychic trauma caused by trying to force such a large needle through unbroken skin.

In a number of cases, for periods of as much as 5 and 6 weeks the cavities went on refilling in spite of repeated aspirations, with no improvement in the local signs, or in the general condition of the patient. These were those in which the infecting focus in the lung continued to pour infection into the cavity. One was a gunshot wound with a bronchial fistula. The cavity continued to refill until the fistula finally healed, after which the patient's improvement was quite rapid. There is nothing to do in such a case but wait until the lesion heals or the bronchial fistula closes. If there be little or no air forced into the cavity through the fistula, and no tendency to tension pneumothorax, healing can sometimes be encouraged by increasing the amount of air injected, thus further compressing the lung and favoring the closure of an opening or cavity on its surface. If, however, there is already positive pressure, resulting from coughing of air through the bronchial fistula into the cavity, this must be relieved by frequent repeated aspiration of air. If the air re-accumulates rapidly with a tendency to displace lung and mediastinum, a needle or trocar should be inserted and left *in situ* so as to permit the escape of air from the cavity as it accumulates. These patients must be watched very closely and seen often, as death may result if a tension pneumothorax is permitted to progress without relief.

TREATMENT OF SPECIAL TYPES OF EMPYEMA

For the sake of emphasis and at the risk of some repetition, I desire to say a few words about three particular types of empyema.

1. *When a large pre-existing pulmonary abscess or empyema pocket ruptures into the clean general pleural cavity.* The sudden rupture into the comparatively clean pleural cavity of the contents of a large fetid gangrenous abscess of the lung, and to a lesser extent that of an empyema pocket, is accompanied by profound shock and occasionally the patient dies before anything can be done for him. These lesions are analogous to similar ruptures into the peritoneal cavity. Aspiration or small tube closed drainage in any form is here out of the question. Immediate shock should be combated with morphine and cardiac stimulants, intravenous dextrose, and transfusion if indicated. As soon as the patient improves sufficiently, a wide opening with rib resection should be made at a point best calculated to secure drainage, and the pleural cavity thoroughly emptied and cleansed, if necessary by introduction of a suction tip

into the more inaccessible portions. When the pleural cavity has been cleansed as well as possible, large tube drainage should be instituted with all the precautions against open pneumothorax already mentioned. The hourglass balloon of Morelli (Fig. 12) surrounding a large tube should answer the purpose well here, giving free drainage and hermetical sealing with protection of the raw surface of the incision by contact with the balloon.

2. *Pyopneumothorax.* If before incision or exploratory puncture, the physical signs and roentgenogram show the presence of fluid and air, one can be quite sure that a bronchial fistula exists. Two factors here complicate the picture: (a) The presence of a continued focus feeding the pus cavity; and (b) spontaneous pneumothorax, air finding its way in through the fistula.

For some time to come, and until the fistula closes, the empyema cavity will continue to be fed with infection, and one must be prepared for a longer period of treatment than otherwise, no matter which method of treatment is adopted. *Prolonged* tube drainage in these cases promotes much granulation in the neighborhood of the tube, rendering the walls of that portion of the cavity correspondingly rigid. The entire pleural surface including its visceral layer becomes denser and less yielding as time goes on, so that when eventually the fistula does close, collapse of the cavity is much more difficult than in the more recent case. If the cavity at this stage does not communicate with the outside, as when aspiration and air replacement has been used, the negative force exerted as the remaining air is absorbed, is exerted principally on the lung surface itself. Being a gradual, constant force, the soft tissues, be they ever so firm, gradually yield and the cavity is finally obliterated. If there has been tube drainage, there can be no collapse while the tube is in place, and even when the tube has been removed the negative pull is more apt to reopen the sinus than distend the lung; hence the greater tendency to chronic empyema. By the judicious use of aspiration and air replacement at this stage any fresh accumulation can be removed and sufficient air can be injected from time to time to give the desired gradual diminution in the size of the cavity. Thus the pull on the lung is gradual and not strong enough to reopen the sinus or bronchial fistula. I have in this way cured at least 2 cases that had had repeated tube drainage.

In an older patient or one who is inclined to be very quiet, especially in the absence of severe coughing spells, spontaneous pneumothorax may not be a serious complication. In children, and in nervous, restless individuals, however, in whom coughing is easily incited and may come on in repeated violent spells, great quantities of air may be forced into the pleural cavity, a little with each coughing effort.

If aspiration or any method of closed drainage is used, the patient must be very carefully watched and frequently seen by the doctor treating the case, and the air permitted to escape if its volume grows large or if any sign of pressure or discomfort develops. This may be done by unclamping the tube where one has been inserted, or performing repeated aspiration if aspiration is being done or before drainage has been instituted. If the reaccumulation of air is rapid, a needle or trocar may be introduced and left in place for a few days. I know of at least one death caused by neglect to observe this precaution.

3. *Purulent mixed infection empyema, complicating pulmonary tuberculosis, or occurring as an incident to transpleural operations.* The former is a very grave condition. It is due to the rupture into the pleura of a cortical tuberculous cavity or abscess, and this lesion must heal, or at least its opening into the pleura close, before the empyema can be cured. Tube drainage is followed in a very large percentage of cases by chronic empyema. Even closed, small tube drainage is likely to do the same, especially if any form of suction is used, in which case the cortical lesion is thereby prevented from closing and reinfection of the pleura continuously favored and encouraged.

Aspiration with replacement of air is here the ideal treatment. The amount of air introduced may be increased to the amount thought most calculated to compress the lung sufficiently to favor the closure of the cortical lesion on its surface. If, however, this lesion happens to be in a stretched area of lung such

as in a band reaching from the chest wall to the collapsed lung, then the more the lung is compressed the more the band becomes stretched and the more closure of any lesion in its substance is prevented. Hence, it may become necessary to cut this band away from the chest wall before the empyema can be cured. One might use for this purpose the instrument of Jacobaeus that is used like an operating cystoscope. It is introduced through a large trocar or small stab wound, and the band cut with a low power cautery. On the other hand, the chest may be deliberately opened through a long intercostal incision and the band cut under direct vision. This seems a formidable procedure, but my experience wi'h 1 case (4) makes me inclined to feel that it should be done more frequently. This was a young man with an old fibrotic tuberculous process in the right lung, with pyopneumothorax with mixed bacterial infection which resulted in a cure after repeated aspiration and air replacement before and after the incision of a band by open operation.

The intrapleural pneumolysis of Jacobaeus and the open treatment of these bands by free thoracotomy have been done in cases of pulmonary tuberculosis receiving artificial pneumothorax where these bands prevented the complete collapse of the lung. They are considered as somewhat serious procedures, however, because of the possibility of the development of purulent mixed infection of the pleura. The same is true of all operative procedures on the lung even in non-tuberculous patients.

If the case just cited is to be taken as a guide, and successful operation deemed possible in the presence of empyema, then the onset of an empyema after a transpleural operation should not appear as such a formidable complication. I believe this to be one of the most important uses to which the treatment by aspiration and air replacement will lend itself.

CONCLUSION

In favor of periodic evacuation and air replacement may be said:

1. It can be used as a preliminary to any other method without harm.
2. It can be used when other methods have failed. I have done so in two instances.
3. It leaves no scar or deformity especially if a small stab is done before introducing a large needle.
4. Patient is not constantly bathed in pus, not encumbered with apparatus, is up and about most of the time.
5. Less danger of metastatic abscess. Boyd says this is practically impossible in an untraumatized pleura.
6. The cost of many dressings is saved.
7. Least probability of chronic empyema.
8. Least trauma, greatest probability of minimum residual pleural adhesions.
9. With proper precaution should be safer and result in lower mortality than any other method.
10. It is especially valuable in the presence of pulmonary tuberculosis.
11. It lends itself admirably to rendering safer all operative procedures within or through the pleural cavity.

Against the method it may be said:

1. It should not be used in sudden overwhelming infection of pleura by ruptured abscess, etc.
2. There is the danger of tension pneumothorax. This is, I believe, its most serious objection.
3. Chest wall infection is possible. I have seen only one superficial abscess and very few pustules.
4. During the intervals between treatments, a certain amount of pus is present, giving fever, malaise, etc. This usually is only evident 1 or 2 days before the next treatment. The patient is practically well the remainder of the time.
5. It requires more frequent contact of surgeon with patient and more frequent reexamination and roentgenograms.

It is impossible to say all that may be said of empyema in any one article such as this. I have, therefore, limited myself to a discussion of the truly clinical phenomena which the surgeon meets and must have in mind in treating the patient. Nothing is said of bacteriology and histological or microscopic changes. I have tried to avoid theory, clinging as closely as possible to known facts.

I hope I have made it plain that the air replacement method combined with aspiration or with stab wound evacuation is not just another "*new discovery* aspiration treatment." It is not merely aspiration; it removes the pus and produces the same condition that results after tube or any other drainage, that is, a clean cavity filled with air. The cavity is sealed, there is no strain on its walls and the more air present the longer it takes for absorption, and the more time the endothelial surface has to return to normal. It is not necessary, therefore, to presuppose that there should be any deviation from the normal process of healing in order to bring about a cure by this method.

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INFLAMMATION[1]

SIR GEORGE LENTHAL CHEATLE, K.C.B., C.V.O., F.R.C.S., LONDON

As a teacher I have always had great difficulty in making clear to the student what inflammation really is and where the process ends. Most writers on the subject seem to me to be in the same difficulty. Textbooks on pathology, with the exception of Thoma, either imply or state definitely that Burdon Sanderson's definition of inflammation is a true one. In 1872 (?), Burdon Sanderson laid down that "inflammation is the succession of changes occurring in a part, as the result of injury, provided that that injury be not so excessive as to destroy the vitality of the part." This definition has no time limit, the nature of the injury is not specified, and it includes events that were either well known or only just conceived, at the time it was made. As the definition stands, it would include today processes of infection, local and general immunity, phagocytosis and the repair of damaged tissue. Even the incidence of certain benign neoplasms and of sarcoma and carcinoma could be included. It is so all inclusive that the common saying "inflammation is the basis of all pathology" would apply. This application would be meaningless, as if it were said that biochemical or nutritional changes were the foundations of all pathological changes. Twenty years before Burdon Sanderson made his historical definition, Lister published his classical investigation upon "The early stages of inflammation" which appeared in the Philosophical Transactions of the Royal Society in 1858. Lister conceived that inflammation is a pathological process, and he ended his researches in these words—"whenever inflammation, congestion, or, in other words, that disturbance of the circulation which is truly characteristic of inflammation, exists in any degree, the tissues of the affected part have experienced to a proportionate extent a temporary impairment of functional activity, or vital change."

Before Lister, John Hunter had conceived that inflammation was active in its nature, and consisted in an exaltation of the affected parts, and that any increase of blood supply that might accrue to an inflamed part would necessarily induce an increased growth, or action, of that part, and, as a result, induce the repair of damaged tissue.

Let me take these notions more in detail.

John Hunter transplanted cocks' spurs into their combs. The result was that the spurs grew to enormous size, a condition he put down to the "greater power of action in the comb than in the leg." As a contributory cause of the excessive growth he said there was no stagnation of blood in the veins of the head.

Hunter also considered that the new blood vessels that are formed in newly extravasated and uniting substance in the healing of wounds stimulated healing by giving "power of action."

Turning to Hunter's transplantation experiment, some years ago I repeated it, and besides transplanting the spurs into the cocks' combs, I transplanted them into the subcutaneous tissue of their necks. All these spurs grew to the same extent in the same time in their new situations, and all the growing spurs were provided with a special leash of blood vessels for their nourishment. The explanation of the excessive growth in the spur when transplanted in the comb cannot have been due to the greater vascularity of the comb, or to the freedom of the venous return. The same amount of growth took place in the same time in the subcutaneous tissue of the birds' necks. In this plane of tissue there is very little blood supply compared with the normal cock's comb. Nor could the excessive growth in that part be due to its "greater power of action" than in the leg, unless the subcutaneous tissue of the neck also has a greater power of action. The great increase of size that occurred in the spur when transplanted into the comb, and also into the subcutaneous tissue of the neck is capable of another explanation. In these new situations

[1] Presented before the Clinical Congress of the American College of Surgeons, St. Louis, October 17–21, 1932.

the spurs were not subjected to the wear and tear of life to which they are exposed in their normal positions.

It is difficult to see exactly what Hunter's experiment does prove. Biological laws of function, physiology, heredity, and so forth, are so interfered with by altering the normal position of a spur, that the results of the experiment become too complicated to render an explanation possible without further evidence. For example, if Hunter were right in his conception that the spur grew to so large a size because the comb possessed greater power of action than the leg, and because the venous return was more perfect, the following question would naturally arise and demand an answer. How is it that a normal comb ceases to grow when it is in possession of so much "power of action" as to be able to induce such enormous growth in another structure.

The reason of the increase of growth in the spurs when transplanted to this new situation is probably more complicated than the one I just now adduced, although it may have some bearing on the matter.

I do not believe that Hunter's experiment can be explained by the spur being transplanted into a part where the blood supply is greater than in its normal position. The neck control experiment negatives that explanation. Nor do I believe that there is any evidence in support of the theory that an increase of blood supply will alone induce an increase in growth or an incitement to grow. The incidence and maintenance of normal growth, of repair, and of neoplasms depend on many more factors than merely the increase or diminution of blood supply. Yet they may all have this in common, viz., that the accurate knowledge of what is occurring in one of these instances may have a great bearing on what is occurring in the remaining two.

Turning again to the observations of Lister on "the early stages of inflammation," in this paper Lister chiefly limits his observations to showing that an injured blood vessel is dilated to the state of temporary paralysis, that stasis occurs, that red and white blood corpuscles tend to adhere to each other, and to the blood vessel walls. Further, that the arrest of movement of the cilia of ciliated epithelium and the cessation of movements of the pigment granules in pigment cells were proofs of impaired functions in the inflamed parts. So far as I am concerned with two additional factors, Lister's conception appears to me to be the essence of inflammation. The additional factors to which I have just alluded are the exudation of plasma and limited emigration of red and white blood corpuscles from the injured blood vessel walls. I cannot understand why Lister did not include these two factors in his description. Waller[1] in 1846, had described them, but no notice was taken of Waller's work until Cohnheim called renewed attention to it in 1867, 1869, and 1873. Exudation of plasma and emigration of red and white blood corpuscles occur *pari passu* with the other changes that Lister described, and therefore necessarily should be included in early changes. In fact, stasis of the corpuscles in an inflamed area is due to the escape of plasma from the injured blood vessel walls, and emigration of red and white blood corpuscles has occurred before stasis takes place.

I did not know Lister until over thirty years after his work on inflammation. By this time his life was fully occupied in teaching the world the results of his epoch making and more recent discoveries. Having settled the matter that inflammation is a pathological process, he was disinclined to open the matter again and did not inform me of the nature of the events he would have included in an investigation into the late stages of inflammation. Lister's conception of inflammation, with the addition of the immediate exudation of plasma and a limited emigration of red and white corpuscles, is from my point, the state of inflammation, and there, upon resolution of these changes, the process stops. Inflammation therefore, from my standpoint, forms only one of the effects that may occur after injury to a part. The nature, degree, and duration of the injury seem to me to induce much more vast and complicated events which should not be included in inflammation. These eventful changes in the parts injured may be entirely different from each other and affected and controlled by different problems;

[1]London and Edinburgh Philosophical Magazine, Vol. xxix, p. 397.

while the process of inflammation as I have conceived it remains the same.

Still, I cannot imagine a more dramatic or descriptive term than that of "inflammation" that was applied by prehistoric observers to a hot, swollen, red, and painful part. Much water has passed under the bridges since the early ages prior to and including the first half of the nineteenth century. Infection and its consequences, immunity and infection, the normal growth of tissues, the repair of tissues and the formation of neoplasms have become separate problems, and yet they are being described at present in the one inextricable tangle of "inflammation."

The knowledge of these things, incomplete though it be, is so vast and so rapidly accumulating that I feel these facts alone demand their exclusion from the subject of inflammation and that a limit should be put to its action and influence.

I am fully aware that a great deal I have said is purely contentious and may be regarded as being entirely wrong. I admit that it represents only a personal opinion. Yet I believe I shall carry most pathologists with me when I say that the time has come to exclude repair and the formation of neoplasms of all kinds from the subject of inflammation. It is gradually dawning on mankind that they are under such definite and complete control of the body in some instances and under a disturbance of control in others, that they should not be considered under the head of inflammation. Directly one cell begins to divide into two cells a fresh element has been established and although it may be the effect of injury, it is not necessarily the effect of inflammation.

Let me go more into detail by speaking of four subjects. The first (a) is repair of tissues; the second (b) is the formation of fibroadenomata of the breast; the third (c) is the formation of papillomata in the breast; and the fourth (d), some local aspects of infection.

a. In the repair of tissues there is an example of organized and beautifully controlled growth. The control is so definite that the growth cannot be explained as being due only to the presence of growth stimulating agents induced by injury. If that were so, tumor formations would be expected, rather than definite organized growth. There is also something more at the back of it all than the presence of hormones. Why should epithelial cells which have covered a raw surface cease to multiply on the instant the raw surface has been covered? No more complete control of growth can be imagined than that which is occurring in the tissues of a healing ulcer of the skin. Until it is covered by epithelium, an enormous number of blood vessels are provided for the nourishment of the granulation tissue, but directly the ulcer has been covered by epithelium, these newly formed blood vessels begin to disappear, and those that remain are only those that are sufficient in number to maintain the nourishment of the part. The co-ordination of the blood supply to the demands of growth and the subsequent maintenance of nourishment is perfectly timed and masterly in execution.

The repair of tissue does not depend upon a haphazard supply of blood vessels. Sufficient nourishment is supplied to meet the demand, and when that demand ceases the number of blood vessels which have become unnecessary, spontaneously vanish. Even the formation of keloids is under some kind of control, which is, in all probability, local and systemic control.

By examining microscopically the fractured ribs of guinea pigs from the moment of injury to 36 days, I have been able to watch all the stages of a healing fracture. Besides learning a great deal more than I knew before, the prolonged and orderly sequence of events convinced me that they could not have been due to inflammation, or to the excretions of stimulating substance of growth due to the injury or to the uncontrolled action of hormones.

How can anybody maintain that so complicated and controlled an event as normal ossification is an inflammatory process?

I arrived at the same conclusions upon examining microscopically the common carotid arteries of cats from the moment they were ligated until 14 days afterward (Figs. 1 and 2).

In uninfected specimens the smallness in number of the emigrated leucocytes is sur-

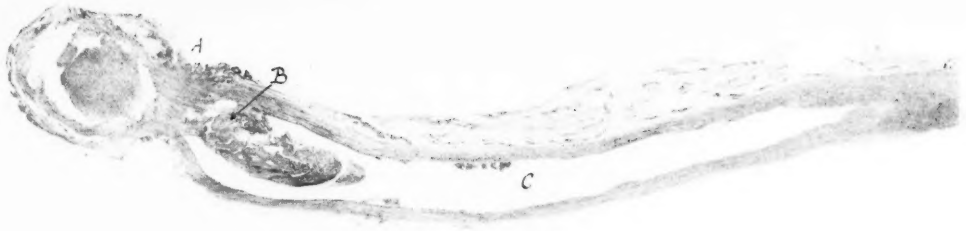

Fig. 1.

Fig. 1. The carotid artery of a cat 7 days after ligation in continuity. *A*, Seat of ligation; *B*, the organizing blood clot at the site of the injured internal and middle coats of the artery. The shaft of the arrow *B* is passing through an area where the endothelial cells have gone and newly formed connective tissue can be seen growing from the subendothelial connective tissue into the organizing clot; c, The lumen of the artery.

Fig. 2.

Fig. 2. The carotid artery of a cat 14 days after ligation in continuity. *A*, Seat of ligation; *B*, extensive hyperplasia of the subendothelial connective tissue extending far along the course of the artery and diminishing the size of its lumen.

prising. The repair of the arterial coats that had been ruptured at the seat of ligation took place from the subendothelial connective tissue and not by multiplication of the endothelial cells. The only multiplication they underwent was in covering the newly formed connective tissue derived from the intima at this spot. Moreover, the lumen of the artery at the end of 14 days had diminished by an increase of the connective tissue of the intima immediately beneath the endothelial lining which remained normal and not by the organization of a blood clot, as I had previously supposed.

The formation of adhesions are good examples of purposeful growth of cells which appear to be carrying out inherited functions. In this connection I once had the opportunity of examining microscopically an excised bursa patellæ that had suffered from injury unconnected by infective process. I excised the bursa 10 days after the injury. The inflammation induced an exudation of plasma within the bursal sac. The plasma coagulated and thus formed a mesh work of fibrin. Where the endothelial cells lining the bursa had been rubbed off, the branches of fibrin remained attached to the bursal wall and were continuous with fibrin therein. These attached fibrinous branches became, like hop-poles, supports for the upgrowth of fibrous connective tissue cells, which took along with them blood vessels for their nourishment. The formation of the adhesion was definitely finished by the covering of this growing connective tissue by a layer of endothelial cells continuous with those lining the bursal sac. The remains of the fibrin could still be seen in the centers of the young adhesions (Figs. 3 and 4).

b. The neoplasias of the breast, known as fibro-adenomata, may at first appear to be growths that exhibit no control in their formation. The contrary is the fact. They are under some control that cannot be explained merely by inflammation to which their presence is so often imputed. There is often no sign of inflammation. Besides that, the signs that are supposed to be indicative of "chronic mastitis" are present in almost every infant breast at birth, and I would not regard the condition as inflammation at all.

First, let me take the fibro-adenomata that appear at puberty. In their simplest states they are formed by precisely the same tissues that are undergoing physiological activity

Figs. 3, left, and 4. The two extremities of an adhesion in the course of its formation. In Figure 3, the fibrin of the base of the adhesion and its continuity into the wall of the bursal sac is well shown. Also the mesh work of fibrin with which the bursal sac was filled can be seen above the adhesion. The microscopical specimen was cut from a bursa patellæ that had been injured 10 days before it was excised.

elsewhere in the same breast. New glandular elements of ducts and acini may be formed in these tumors, and whether newly formed or not, they are usually surrounded by dense layers of pericanalicular and periacinous connective tissues. It is this newly formed pericanalicular and periacinous connective tissue coming in contact with the supporting connective tissues of the breast that gives these tumors the macroscopical appearance of encapsulation. To classify all these perturbed physiological changes as being inflammatory does not seem to me to touch the problem of their existence.

Second, let me take the intracanalicular fibro-adenomata, the connective tissue parts of which I have traced to the subepithelial connective tissue. These tumors occur later in life than those of puberty, generally about the fourth or fifth decade. The glandular epithelium covering these tumors often dips down into the connective tissue element and forms perfectly developed normal looking acini, which any young breast would be proud to possess. Irregularly planned new breast tissue has been developed in these tumors, the formation of which is under some control, even if it be an irregular control.

c. Next, let me take the formation of papillomata in the ducts of the breast. From small beginnings of stalks of pericanalicular tissue containing the elastica which are covered by epithelium, these stalks coalesce and in many instances papillomata develop into duct tumors consisting of irregularly disposed ducts and acini. These tumors form another example of some disturbance of control and an aborted attempt to form new breast glandular tissue. Nothing can convince me that they are evidence of only inflammation or that inflammation has anything to do with their formation.

d. Lastly, let me take evidence on these matters given by the morphological appearances in the subcutaneous tissues that have been inoculated with a culture of Staphylococcus aureus, sufficient in dosage and virulence to give rise to a localized abscess that ruptured in 7 days (Figs. 5, 6, and 7).

In this experiment I examined microscopically the whole of the affected area varying from the effects of the immediate inoculation to 10 days afterward. I have described them in detail in Choyce's *System of Surgery* and I need not here repeat them. The impressions I gained from a morphological study of these events were as follows:

1. The course and results of an infection depend primarily upon a balance or an adjustment between the resistance of the host and

Fig. 5. Part of the margin of an acute staphylococcus abscess in the subcutaneous tissue of a guinea pig 4 days after inoculation. *A*, The center of the abscess; *B*, the edge of the abscess which in some parts is in contact with the strands of fibrous connective tissue that has already undergone hyperplasia while at others the abscess is still spreading among fat cells; *C*, the strands of fibrous connective tissue that are undergoing hyperplasia at some distance from the edge of the abscess.

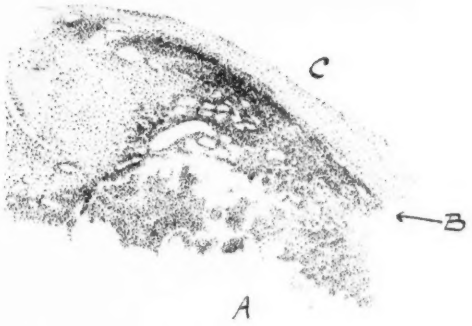

Fig. 6. Part of the margin of the same abscess. The oval and circular spaces are newly formed blood vessels in a line with the arrow *B* and are situated at the edge of the abscess in the newly formed connective tissue there situated. *A*, The center of the abscess; *C*, a strand of fibrous connective tissue that has undergone hyperplasia.

chiefly the virulence of the micro-organisms at the actual moment of infection.

For example, take the rapid death of a host from a generalization of the infection. Here, either the resistance of the host is so low, or the degree of virulence of the micro-organism is so high, that no time is allowed for the formation of an acute abscess. Hence, when an acute abscess forms, it can be accounted for only by the existence of an adjustment between the powers of resistance of the host and the degree of attack on the part of the micro-organism.

During the course of even the formation of an acute abscess, the process of the host's resistance may become lowered or the virulence of the micro-organism may become increased, yet my opening statement remains a sound one. The whole process first of all depends upon the degree of adjustment of factors of host and micro-organism at time of infection.

Again, the first thing that occurs in the formation of an acute abscess is the death of tissue with which the infecting agents come into contact.

The next thing that is obvious is the tremendous emigration of polynuclear leucocytes, most of which are at first killed. However, the process of emigration of leucocytes continues.

The third and fourth events are the emigration of lymphocytes and the hyperplasia of the normal strands of fibrous connective tissues that support the subcutaneous fat. These events occur immediately around the developing abscess, and by the fourth day they are well established. I do not know whether the inducement of emigration of the leucocytes is the same in a suppurating process as it is in the stage of inflammation due to mechanical injury. If the inducing agents be the same in both processes, then it could be claimed that inflammation is a great factor in suppuration.

If, however, the inducement of the leucocytes to emigrate in a suppurating process be not the same as in inflammation produced by mechanical injury, then not inflammation but some other process is in operation. I doubt very much whether the factors that induce the emigration of leucocytes are the same in infective and non-infective lesions.

The bone marrow in which the enormous increase of polynuclear leucocytes is manufactured, is not in a state of inflammation. In fact, the whole of this part in the formation of an acute abscess may be considered as being

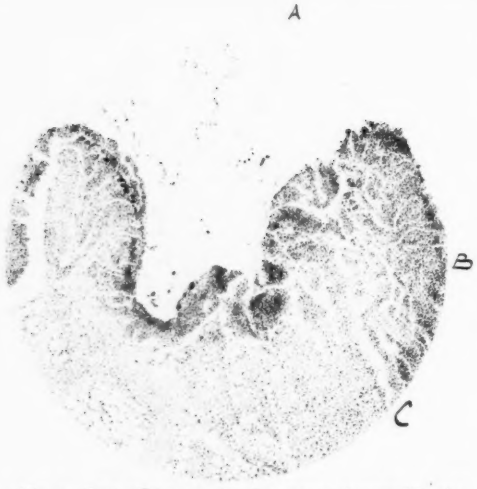

Fig. 7. Part of the margin of an acute abscess (Staphylococcus aureus) stained by Gramm's method, 7 days after inoculation. *A*, The center of the lesion; *B*, the marginal ring of massed staphylococci encircling the edge of the abscess; *C*, the surrounding subcutaneous fat and connective tissue.

questions of immunity rather than being concerned with the process of inflammation. Micro-organisms at first multiply and are mixed, with no arrangement in the lesion. By the seventh day a very definite arrangement has occurred in which a dense mass of micro-organisms completely encircles the abscess cavity in the form of a ring. The ring of micro-organisms is situated at the extreme edge of the abscess beyond which none can be seen. It is impossible to explain the meaning of this ring, beyond suggesting it has something to do with the question of immunity (Fig. 7).

Turning to the later events, such as the hyperplasia of the normal supporting strands of connective tissue during the process of formation of an acute abscess, here again the establishment of immunity transcends in importance any concurrent process of inflammation that there may be.

The hyperplasia of connective tissue that takes place around an abscess could not occur if the micro-organisms were able still to cause the death of tissue they manifested on their first introduction.

An abscess does not get well and does not become localized because it is encysted by an abscess wall. Even when the abscess has been opened and the lesion is getting well, pus can still be seen in tissues where there is no limiting wall.

These observations definitely show that infection and immunity, and not inflammation, are the important factors the body is concerned with in the formation and cure of an acute abscess.

THE DETECTION OF THE CLINICALLY LATENT CANCER OF THE CERVIX

With a Report on Schiller's Lugol Test[1]

WILLIAM P. GRAVES, M.D., F.A.C.S., Boston

THE treatment of cervical cancer is at the present time entering upon a new and more hopeful phase, made possible by fresh scientific knowledge both of malignant disease in general and of that particular aspect of it that forms the subject of this paper.

The combat against cervical cancer during the last 30 years has accomplished much. The formidable operations of Wertheim and Schauta which demonstrated the possibility of permanently curing the disease, have given way for the most part to the simpler and more efficacious methods of radiation. Elaborate follow-up studies of treated cases have formulated the percentage of permanent cures to be expected, relative to certain stages of progress of the disease. The total number of cured cases, though not large enough appreciably to affect the general mortality statistics, is nevertheless encouraging. It has at least established a fact of prime importance, namely, that cancer of the cervix is frequently cured by the means at our disposal, the chances of cure being directly proportional to the timeliness of the attack.

The logical conclusion is that every cancer of the cervix passes through a period, in its life history, during which it is theoretically one hundred per cent curable. This is the rock on which the hope of controlling the disease is at the present time based. Ultimate success depends on the co-ordinated efforts of every member of the profession, who treats women at all, to detect and bring to treatment the early case.

Now, for the past 30 years we have all been studying and treating cervical cancer in its advanced stages. All clinical and pathological characteristics with which we are so familiar are those of advanced cancer. The standard symptoms of fetid discharge, bleeding, pain, the local changes of tumor formation, metastasis and ulceration, the histological picture of invasion and multiplication of cells, all are manifestations of comparatively late stages of the disease. The great array of tables portraying the percentages of mortality, recurrence, and cure represents almost exclusively the treatment of advanced cancer. The division of cervical cancer topographically is merely an inaccurate estimate of the degree of progress in an already protracted disease.

It is difficult to realize how few incipient cancers of the cervix have until recently ever been detected and consciously treated. Only the merest handful have been reported in the literature, the discovery of such a case being usually by pure accident, and hailed triumphantly as the rarest of finds. And yet since the incidence of incipient and terminal cancer is identical, patients must repeatedly be on our examining tables who without impairment of health, and often without symptoms, harbor a disease which at the same time is invisible to the keenest eye and intangible to the most sensitive touch.

The treatment of advanced cervical cancer has actually reached an *impasse*. Surgery has attained its peak of usefulness. The limitations of radium are already in sight. Follow-up records are now a necessary routine of the clinic but can teach us little that is new concerning the results of treatment along the old lines. The hope of diagnostic, immunizing, and curative sera must probably be abandoned in the face of scientific evidence that cancer is primarily a local and not a constitutional disease. Metals in colloidal form have proved disappointing since they are too destructive to the normal tissues. In view of the amazing effects of radium, we look instinctively to the scientists to discover some new form of radiation in which the human body may be bathed and harmlessly cleansed of all malignant tendencies, an idea not entirely chimerical, but certainly at the present moment utopian.

[1]Presented before the Clinical Congress of the American College of Surgeons, St. Louis, October 17–21, 1932.

Fig. 1. Photomicrograph showing the abrupt change from normal to cancerous epithelium. The line of demarcation is always oblique since the change takes place in the cells of the basal layer first. The process is therefore farther advanced in the lower than in the upper cells. On the left of the line are seen the well ordered layers of the normal epithelium. On the right are seen the dark atypical cells of the cancer. The interpapillary plugs are irregular and clubbed but there is no elevation on the surface nor invasion of cancer cells in the stroma. Note the dense inflammatory infiltration beneath the cancerous portion. The disease is progressing from right to left by assimilation like ink on blotting paper. Taken from Schiller (5, p. 352).

In the search for the early case it must first be recognized that the life history of a cervical cancer covers on an average from 10 to 12 or more years. This includes a long irritative stage of chronic *cervicitis*, and a shorter though still protracted period of *clinical latency*, during which the cancerous change though actually present does not attract the attention of the patient or her attendant.

Until recently our best means of discovering cervical cancer in its latent stage has been the policy of timely repair of the inflamed cervix with a routine biopsy of the tissues. Many unsuspected cancers may be discovered in this way. But this policy has not been sufficiently widely adopted and there is still an unaccountable reluctance to repair dangerous cervicitis until the age of child-bearing is passed. Even when rigidly carried out the system has been open to frequent error. The pathologist unfamiliar with the incipient cancer-changes may miss the diagnosis. Or the operator with nothing to guide him may miss the cancerous area entirely in removing tissue for biopsy.

In recent times the invention of the colposcope by Hinselmann has been a laudable move in the right direction. But the instrument is expensive, requires expert manipulation, and is not well adapted to the use of the general practitioner.

In order to meet the difficulties of the situation it is evident that two things are primarily needed: first, a clearer knowledge of the histological appearance of an early cancer; and second some simple test by which the latent area may be accurately located for purpose of biopsy. In the efforts to solve these two fundamental problems the work of Walter Schiller, of Vienna, stands pre-eminent and has been taken as a basis for this report.

Schiller approached the matter by first studying exhaustively the cervices of 135 uteri that had been removed by total hysterectomy for causes other than cancer, cancer itself being unsuspected. In this series of specimens he found 4 cases (2.96 per cent) with microscopic evidence of what he regarded as the earliest stages of cervical cancer. His observations and conclusions from this study harmonize closely with those of other authorities working in the same field and may be summarized as follows:

Fig. 2. Change from normal to cancerous epithelium. Note the oblique line of demarcation. There is clubbing of the interpapillary plugs, but no elevation or invasion of the cancerous epithelium. (Taken from Schiller.)

Under the stimulation of chronic irritation the cancer process, in a manner unknown, starts in a single indifferent cell of the basal layer of the epidermis of the portio vaginalis. As has been shown by Carrel, Loeb, and others the malignant cell at first produces a virus that is capable of inciting malignancy in neighboring normal cells. This process is called *assimilation* and is the first stage of malignancy in cervical cancer. During this stage the growth extends laterally like the spread of a drop of ink on blotting paper. There is at first no thickening or change of consistency in the epidermis so that the affected area cannot be distinguished by sight or touch from the surrounding normal tissue.

A cancerous process thus inaugurated never heals spontaneously but progresses inexorably to what may be called the late stage, that of invasion. The cancer now extends by a new force, namely by the *multiplication* of its own cells which is so irresistible that it invades and destroys the neighboring tissues. Here we have the late cancer with which we are all so familiar—the nodular thickening, the ulceration and metastasis, the infection, necrosis, and fetid discharge and the bleeding from broken or eroded vessels.

The histological picture of an early cancer in the assimilation stage is striking and

Fig. 3. Abrupt change from normal to cancerous epithelium. In this case there appears on the right a beginning of invasion of the stroma but there is no elevation of the surface. (Taken from Schiller.)

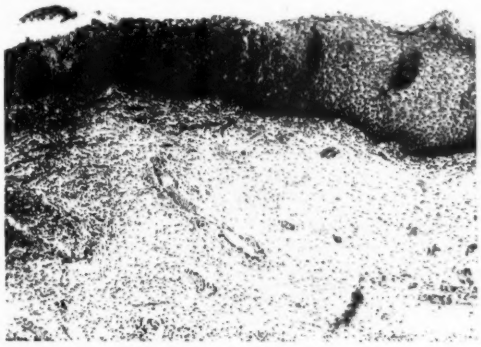

Fig. 4. Case of early unsuspected cancer discovered at the Free Hospital for Women by routine biopsy after trachelorrhaphy. Note the oblique line of demarcation, and the intense inflammatory infiltration beneath the cancerous area. Note also that there is no invasion of the stroma and that the cancerous strip of epithelium is actually thinner than the normal portion. The two dark spots in the normal epithelium are not cancer but the tips of papillæ in cross section. (Pemberton and Smith.)

characteristic. Most prominent is an abrupt demarcation between the normal epidermis and the cancer, which always appears as an oblique line. On the one side are the normal epidermoid cells in their well ordered three layer arrangement; on the other side are the dark and stormy cells of the cancer, with a blurred or broken basal line, above which appears a confusion of cells irregular in size, form, and staining properties, and with little or no evidence of differentiation and layer building. All the other signs of cancer are seen *excepting that of invasion of the stroma* and when this is present the disease is *ipso facto* in the second or advanced stage. Without enumerating the finer details of the picture we may thus recapitulate Schiller's conclusions:

1. Cancer of the cervix starts in the squamous epithelium of the portio near the os and at first spreads laterally, i.e., superficially.

2. It always starts in the unbroken epithelium and not in an ulceration.

3. Histologically the chief determining points of diagnosis are first, the oblique line of demarcation between the normal and abnormal areas, and second, the anaplastic atypia and polymorphia of the abnormal cells.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 5. Lugol test. Lacerated hypertrophied cervix. Cancer absent. The normal epithelium of the portio and vagina stains a dark, almost black mahogany color. The everted mucous membrane of the endocervix does not take the stain and appears light red or pink.

Fig. 6. Lugol test. Cancer present. The drawing is from one of the author's cases, and shows the normal tissue taking the dark stain. On the anterior lip is seen a patch of cancer, revealed by the Lugol test, where the stain does not take, leaving the area almost white and sharply delineated from the normal tissue. In this case the disease had already reached the multiplication stage as shown by biopsy but was still sufficiently early to warrant a favorable prognosis for radium or operative treatment. Radium treatment was used.

Fig. 7. Lugol test. Chronic cervicitis. Cancer absent. Drawn from one of the author's cases. On the posterior lip was a light patch very slightly tinged with brown. The edges of the area blended with the color of the normal background instead of being sharply defined from it as in cancer. Biopsy showed an intense cervicitis with some loss of epithelium in the upper layers. On the anterior lip are several Nabothian cysts, which often take a deficient stain on the surface.

But this histological revelation of the earliest appearances of cancer would be of little practical value, without the ability to discover the location of a process not distinguishable by eye or touch. To meet this difficulty Schiller has devised an ingenious test which bids fair to be of general clinical value.

The test is based on the discovery by Lahm that the upper layers of the normal epithelium of the portio and vagina contain rich masses of glycogen which disappear when the epithelium becomes cornified or changed by cancer. In the normal living tissue the glycogen of the upper layers of cells is stained in a few seconds a deep mahogany brown by iodine in watery solution (Lugol's). A superficial area of early cancer being devoid of glycogen does not receive the stain and stands out startlingly white or pink against the deeply colored, almost black background of the normal tissue.

I can best present the clinical value of this test by describing my own experience with it. I began using it about 9 months ago, with half-skeptical curiosity, but soon adopted it as a routine procedure on all cervices in the operating room and to some extent in office examinations.

During the period 3 early cases have been encountered which in respect to the Lugol test and the microscopic findings correspond to Schiller's dicta. In each case there had been suspicious contact bleeding so that the cases were not as early as some described by Schiller in which the discovery of cancer was made out of an entirely clear sky. However, in all of these cases there was no tactile or visual evidence of cancer, and in making the biopsy *there was no guide to the location of the cancer* excepting that of the Lugol test. Without it the specimens for examination would have been removed at random and the diagnosis of cancer might readily have been missed.

Schiller, in 553 clinical tests, found it positive (i.e., stain deficient) in 140 cases, 9 of them showing early cancer.

The test, simple as it seems, is not without its limitations. It appears to be completely reliable when it is clinically negative, that is to say when all the tissues take the normal stain. This claim made by Schiller has been repeatedly confirmed by our own biopsies.

The test is therefore specific for determining the *absence* of cancer of the portio and vagina. This of itself is an inestimable aid.

But there are several conditions that obscure the test and with these the examiner should be thoroughly familiar.

1. The stain does not take on glandular epithelium like that of the endocervix. Hence an eversion (ectropion) would appear pink. The same is true of the epithelium of an adenocarcinoma, so that this type of cervical cancer must be sought for in the usual manner. Fortunately such cancer is rare.

2. Ulcerations and erosions do not take the stain since they have no epithelial covering.

3. In areas of chronic cervicitis the epithelium seems often to be deficient in glycogen, taking a very light brown which blends with the surrounding deeply staining tissue instead of being sharply defined from it as in cases of true cancer. We now, after the biopsy, dissect off the suspicious area and close the wound with fine catgut.

4. The normal stain is prevented or obscured by slight trauma such as that from tenacula or scrubbing with gauze. This is caused by the rubbing off of the upper layers of epithelium in which the glycogen is chiefly deposited.

5. The cervix and vagina of the hypoplastic and atrophic individual stains lighter than the normal. It is especially deep during pregnancy.

6. Pus stains black since leucocytes are rich in glycogen. Necrotic tissue also stains black but clean, living granulations do not take the stain. A film of mucus prevents the stain. Blood and douche water obscure the reaction.

7. Hyperkeratosis prevents the stain as in leucoplakia, lues, and exposed areas in prolapse.

8. The test is of limited value in diagnosing advanced cancer, since the superficial assimilation stage is usually lost in the melèe of self-reproducing cells. Sometimes superficial areas detectable by the Lugol test may be found beyond the border of the advanced cancer especially in the fornices of the vagina, and this may serve as a guide in determining the limits for a radical operation. Cancer cells in the advanced stage may regain glycogen and thus give a dark stain with the Lugol's solution. Normal epithelium lying above an invading cancer takes a normal stain as would be expected.

9. Schiller's test is specific for cervical cancer, and is not adapted to other superficial cancers such as those of the vulva and skin in other parts of the body. This is due to the fact that the normal epidermis of the portio and vagina is not cornified and that the upper layers of cells contain a special chemical type of glycogen.

Application. The writer's technique is as follows: A thick swab of absorbent cotton and gauze is prepared on the end of a stout wooden applicator. The swab is first immersed in the Lugol's solution until a copious amount of it has been absorbed. With the upper vagina well exposed by speculum or retractors the swab is then pressed firmly against the anterior lip of the cervix. The upper vagina is in this way flooded with the solution which instantaneously stains the normal tissues (excepting the mucous membrane of the endocervix) almost black. Any area of the portio no matter how small that does not take the stain must be regarded with suspicion. The suspicious area is then curetted with a specially sharpened spoon curette. The strip of epidermis thus secured is placed immediately in hardening solution and sent to the laboratory for biopsy.

CONCLUSIONS

We are finding the Schiller test an indespensable aid in the search for early curable cancer of the cervix. It is specific for the absence of cancer. Failure of the stain indicates certain other abnormal conditions two of which, leucoplakia and intensive cervicitis, are potential precursors of cancer and require treatment. We recommend the test for trial to the general profession.

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THE RESULTS OF RADIUM TREATMENT IN FUNCTIONAL UTERINE BLEEDING[1]

FLOYD E. KEENE, M.D., F.A.C.S., AND FRANKLIN L. PAYNE, M.D., F.A.C.S., PHILADELPHIA

FROM January, 1920, to July, 1931, 423 cases of functional uterine bleeding were admitted to the Gynecological Department of the University Hospital. Three hundred and ninety-one were given radium treatment and of these, complete data regarding its effects upon bleeding are available in 344 and upon menopausal reactions in 336. In all, the bleeding was so profuse or prolonged as to demand surgical measures for its control, no organic lesion in the pelvis could be found to explain the bleeding and there were no evidences of a causative constitutional disease, blood dyscrasia, or thyroid dysfunction. A large proportion had received no benefit from medical measures and in 73, the bleeding had persisted after some form of surgical treatment. Fifty-two patients had been curetted, some as many as five times, usually with no benefit or, at most, relief of from 1 to 6 months' duration. None of the patients had received the present day hormonal therapy, since the period of observation antedated the availability of these preparations. Doubtless, a certain number would have responded favorably to it but our experience has shown that it is by no means a panacea and that at least 50 per cent will require some other form of treatment. Examination under anæsthesia and microscopic study of the endometrium were invariably made.

Our experience with radium dates back to 1913 when Dr. John G. Clark began its use in his clinic and we gratefully acknowledge our indebtedness to him for many of the principles which continue to guide us in this work. As the result of this experience we are convinced of the value of radium in the treatment of benign uterine hæmorrhage, whether of neoplastic or functional origin, but by the same token, this experience has enabled us to appreciate its limitations and has engendered a profound respect for its harmful potentialities when injudiciously applied. Accuracy of diagnosis, an understanding of the effects produced by radium in healthy and diseased structures as well as upon ovarian function, the ability to determine what lesions are amenable to irradiation and careful attention to the technique of application are the essentials of successful radium therapy. When these qualifications are met, the results are, on the whole, satisfactory, and complications are reduced almost to the vanishing point; under other circumstances, undesirable sequelæ are sure to occur.

Much of the adverse criticism of radium is due to its abuse rather than to its use, but even in the hands of those skilled in gynecological diagnosis and familiar with the effects of irradiation, unsatisfactory results are encountered. The cure of functional bleeding by radium is accomplished by its effects upon ovarian function, cessation of which may result in the profound and often lasting disturbances which characterize the induced

[1] Presented before the Clinical Congress of the American College of Surgeons, St. Louis, October 17–21, 1932.

menopause. For this reason, radium should be used only when more conservative measures have failed and then with due regard to its limitations and dangers.

Although radium therapy was the procedure of choice in 92 per cent of the 423 patients, we believe that hysterectomy and roentgen therapy have a place in the treatment of functional bleeding. Radium is preferable to roentgen therapy because its dosage can be more accurately regulated; further, completion of the treatment can be accomplished at the time of diagnostic curettage which should precede either form of irradiation. Hysterectomy or roentgen therapy are chosen when radium has failed or some condition is present which contra-indicates its use, the choice of the one or the other depending in large measure upon the age or nervous stability of the patient.

The absence of both intermenstrual pain and acquired dysmenorrhœa is a characteristic feature of functional bleeding. When pain is associated with irregular bleeding, some organic pelvic lesion is usually present even though examination fails to reveal it, and operation is preferable to radium therapy. With surprising frequency, the wisdom of this decision will be proved when the abdomen is opened.

Radium should be employed with caution, if at all, in patients who have had a previous pelvic operation, since an intestinal loop adherent to the uterus may be seriously damaged by the rays. In a few instances, we have used heavily filtered radium in small dosage successfully but we prefer operation or roentgen therapy.

Patients with profound anæmia react poorly to both radium and roentgen therapy and irradiation of either form should be withheld until the blood has been improved by transfusion and other appropriate treatment. Indeed, blood transfusion may be a curative measure, as we have had occasion to observe in a few cases of adolescent hæmorrhage.

Our confidence in curettage as a therapeutic measure is in direct proportion to the 3 per cent incidence of its use in this series. However, it, too, has a place in the treatment of functional bleeding, particularly in girls and young women when one may hesitate to use radium. At least a few will be temporarily benefited or cured. Even though the results be disappointing so far as bleeding is concerned, the procedure is not entirely futile since valuable data will be afforded by a study of the endometrium thus obtained.

An attempt to estimate what has been accomplished by radium therapy must take into consideration not only the control of bleeding but also the manifestations of disturbed ovarian function which have arisen incident to its use. The criteria of success or failure vary in accordance with the age of the patient. In young women, success is measured in terms of normal menstruation and preservation of the reproductive function, while in women approaching the menopause, the treatment is often a success even when complete cessation of these functional activities occurs. The frequency with which this differentiation must be made, is evidenced by the fact that 50 per cent of the patients in the group studied were under 40 years of age. We have approached the problem of evaluating our results with these standards as our guide. The incidence of control of bleeding, permanent amenorrhœa, and severe menopausal reactions is the yard-stick by which these results are measured.

Throughout this study, we have determined the results from the standpoint of age groups, and Table I gives a summary of the percentage of patients in each decade who received a given dosage of radium. According to our present belief, an initial dosage of between 400 and 500 milligram hours in the group under 30 is high nor would we give between 800 and 1200 milligram hours to nearly one-fifth of the patients between 30 and 40. During this study, it was our custom gradually to increase the dosage with increase in age, and the incidence of 46 per cent shown in the third age group who received between 400 and 500 milligram hours is explained by the fact that the age of the majority of the patients approached the end of the decade. Taken as a whole, comparatively small dosage characterizes this table.

The analysis of dosage outlined in Table I is based on that given at the initial treatment

TABLE I.—DOSAGE OF RADIUM IN RELATIONSHIP TO AGE IN THREE HUNDRED AND NINETY-ONE PATIENTS

Age in years	Number patients	200–300 mgm. hrs. per cent	400–500 mgm. hrs. per cent	600–700 mgm. hrs. per cent	800–1,200 mgm. hrs. per cent
Less than 20	21	62	38	0	0
20 to 30	84	75	24	0	1
30 to 40	91	23	46	12	19
40 to 50	165	0	9	43	48
50 to 60	30	0	0	43	67

TABLE II.—SUMMARY OF RESULTS, WITH THE PATIENTS GROUPED ACCORDING TO AGE

		Less than 20 years, per cent	20 to 30 years, per cent	30 to 40 years, per cent	40 to 50 years, per cent	50 to 60 years, per cent
Result of initial treatment	Bleeding controlled	53	70	90	92	92
	Permanent amenorrhœa	6	0	20	76	85
	Severe menopause	0	4	19	30	3
Patients requiring subsequent treatment		47	30	10	8	8
Final result	Bleeding controlled	88	88	95	99	100
	Permanent amenorrhœa	6	0	24	77	85
	Severe menopause	0	8	21	31	3

only and the results of this dosage are presented under the first portion of Table II. Under the heading of "bleeding controlled" are included both return of normal menstruation and permanent amenorrhœa, hence a second heading was chosen in order to demonstrate the incidence of the latter condition. As would be expected, the highest percentage of those requiring subsequent treatment is found in the youngest age group and this decreases progressively to 8 per cent in those over 40 years. The last portion of Table II summarizes the final results obtained from both the initial and subsequent treatments.

This analysis forcibly confirms the statement previously made that conclusions as to the value of radium therapy must be based not upon the control of bleeding alone but also upon the incidence of amenorrhœa in women under 40 years and severe menopausal reactions at any age. Could we construct an ideal method of treating functional hæmorrhage, it would have for its results return of normal menstruation and absence of menopausal symptoms in women under 40, and either amenorrhœa or normal periods without severe menopausal reactions beyond this age. This Utopian concept can, of course, never be realized, but it gives us a standard by which to measure our results. Applying this measure of perfection, we find that it comes nearest to accomplishment at the two extremes of the menstrual life. Between 30 and 40 years, when preservation of ovarian function is desirable, control of bleeding is but 5 per cent short of the ideal, but in one-fourth of these, control was in the form of permanent amenorrhœa. Further, one-fifth of these patients developed severe menopausal symptoms. During the fifth decade of life, the ideal is practically accomplished in so far as the control of bleeding is concerned, but at the cost of severe menopausal reactions in a third of the patients. These distressing and often deplorable symptoms of disturbed ovarian function cannot be ignored.

Table III has been prepared to show not only the incidence of temporary and permanent amenorrhœa during the different age groups, but also the results of varying radium dosage in each decade. Irrespective of age or dosage, no group was immune to a temporary amenorrhœa averaging 5 months in duration and in no group did a permanent amenorrhœa develop after a dosage of between 200 and 300 milligram hours. With the exception of the 20 to 30 year group, the incidence of permanent amenorrhœa increases directly with the radium dosage, as would be expected. The generally recognized fact that resistance to the action of radium decreases as the age increases is nicely shown in the 400–500 milligram hour group, the exception being the group under twenty. Here, an incidence of 63 per cent temporary and a 12 per cent permanent amenorrhœa may be of no significance since only 8 patients compose it. However, it suggests an increased susceptibility to irradiation as compared with that in women in the next decade. From this analysis it would seem that the ovaries in women between 20

TABLE III. — DEVELOPMENT OF TEMPORARY AMENORRHŒA (T) AND PERMANENT AMENORRHŒA (P) FOLLOWING IRRADIATION IN 344 PATIENTS

The Temporary Amenorrhœa Varied Between 3 to 12 Months with an Average of 5 Months

Age in years	2 to 300 mgm. hrs., per cent		4 to 500 mgm. hrs., per cent		6 to 700 mgm. hrs., per cent		8 to 1,200 mgm. hrs., per cent	
	T.	P.	T.	P.	T.	P.	T.	P.
Less than 20	11	0	63	12	None treated		None treated	
20 to 30	19	0	47	0	None treated		100 (1 patient)	
30 to 40	20	0	40	12	56	22	40	56
40 to 50	None treated		13	57	26	62	3	92
50 to 60	None treated		None treated		22	77	1	90

and 30 are highly resistant to radium or possess a strong recuperative power, since a permanent amenorrhœa did not develop in a single instance, despite the fact that one patient received 1,200 milligram hours. In the next decade, permanent amenorrhœa is noted in 12 per cent, while in the 40 to 50 year group, the incidence rises to 57 per cent after the same dosage which gave none between 20 and 30. The increasing susceptibility to radium after 30 has an important bearing upon initial dosage and will be referred to later.

Table IV shows the incidence of menopausal symptoms, both mild and severe, which developed in the various age groups after the initial dosage summarized in Table I. Although no group escaped the mild reactions, these were for the most part transient and cannot be considered an objectionable feature of the treatment. On the other hand, severe menopausal symptoms are noted in all groups except those under 20, rising to a 30 per cent incidence between 40 and 50. The group between 50 and 60 received the largest average dosage, yet severe symptoms occurred in only 3 per cent. A factor, which contributes to the incidence of severe menopausal symptoms, is the patient's unstable nervous mechanism. The more nervous the individual, the greater is the likelihood of a stormy menopause even under normal conditions and when induced by irradiation, the severity is multiplied. Bitter experience has taught us that this type of woman is ill adapted to radium therapy and that hysterectomy with ovarian conservation should be chosen in its stead.

TABLE IV.—DEVELOPMENT OF MENOPAUSAL SYMPTOMS FOLLOWING IRRADIATION IN 336 PATIENTS

Relationship Between the Severity of the Symptoms and the Patients' Age

	Less than 20 years, per cent	20–30 years, per cent	30–40 years, per cent	40–50 years, per cent	50–60 years, per cent
Severe	0	4	19	30	3
Mild	12	14	25	38	41
None	88	82	56	32	56

The incidence of severe menopausal symptoms, which have followed variations in radium dosage during each decade, is presented in Table V. In general, our analysis shows that the percentage of these reactions increases with the dosage, and this fact is well illustrated in the 30 to 40 year group which reaches the peak of 47 per cent with what is generally recognized as the menopausal dose. Exceptions are noted in the 20 to 30 and 40 to 50 year groups. Individual variations in the reaction to radium are well recognized and increased susceptibility may afford the explanation of these exceptions. Reference to the last two groups of the table shows that with a given dosage of radium, severe menopausal symptoms decrease with each decade until between 50 and 60 they are almost negligible. This is in direct contrast with the occurrence of permanent amenorrhœa and it has an important bearing on the determination of initial dosage in patients over 40 years of age when a combination of amenorrhœa and a low incidence of severe menopausal symptoms approaches the ideal result.

At the beginning of this discussion, the assertion was made that control of bleeding is not the sole standard by which the value of radium therapy is measured, but that consideration must also be given to the incidence of permanent amenorrhœa and severe menopausal symptoms which may develop from the treatment. The associated incidence of these three factors with varied radium dosage during the different decades is shown in the following tables. The results given are those of the initial dosage only.

TABLE V.—THE RELATIONSHIP BETWEEN THE AGE, THE DOSAGE, AND THE DEVELOPMENT OF SEVERE MENOPAUSAL SYMPTOMS

Age in years	2 to 300 mgm. hrs., per cent	4 to 500 mgm. hrs., per cent	6 to 700 mgm. hrs., per cent	8 to 1,200 mgm. hrs., per cent
Less than 20	0	0	None treated	None treated
20 to 30	4	0	None treated	0
30 to 40	0	17	24	47
40 to 50	None treated	31	19	38
50 to 60	None treated	None treated	0	6

TABLE VI.—ANALYSIS OF THE LESS THAN 20 YEAR GROUP BASED UPON INITIAL DOSAGE AND RESULTS

Dosage mgm. hrs.	Bleeding controlled, per cent	Permanent amenorrhœa, per cent	Severe menopausal symptoms
2–300	55	0	0
4–500	50	12	0

The group of 17 patients under 20 was about equally divided between the two dosages given (Table VI). Although the incidence of temporary amenorrhœa was high with the larger dosage, only one patient developed permanent amenorrhœa and the bleeding was not controlled in approximately half of them.

Between 20 and 30 years of age, menstruation was restored to normal in a much higher percentage (Table VII). Permanent amenorrhœa did not develop, but an incidence of 4 per cent severe menopausal symptoms is noted with the smaller dosage. The isolated instances of permanent amenorrhœa without menopausal symptoms and severe menopausal symptoms without amenorrhœa exemplify the individual and unexplainable reactions which may follow irradiation.

Table VIII is particularly interesting because in this 30 to 40 year group an opportunity is afforded to demonstrate the effects produced by variation in radium dosage as well as to support our contention that evaluation of radium therapy must be made in terms of permanent amenorrhœa and severe menopausal symptoms as well as control of bleeding. The results are on the whole satisfactory in so far as the control of bleeding is concerned but, with the exception of those obtained from the minimal dosage, the toll exacted by permanent amenorrhœa and severe menopausal symptoms has been high. At an age when the preservation of ovarian function is of vital importance, such results cannot be considered successful, irrespective of what the effect on bleeding has been.

The group between 40 and 50 comprises 147 patients. Permanent amenorrhœa is a desirable result during the fifth decade, and we find that with a dosage as small as 400 to 500 milligram hours, it has occurred in 57 per cent and the bleeding has been satisfactorily controlled in 86 per cent. Practically the same figures obtain with increased dosage until we reach the 800 to 1,200 milligram hour group when the results are but little short of perfection. However, final judgment must be withheld until the results are measured in terms of severe menopausal reaction. Although the incidence of 31 per cent with the minimal dosage is significant, we have reason to believe that the figures obtained by our analysis of the two larger groups are more dependable. Here we find that the dosage usually employed meets expectations in the control of bleeding, but that severe menopausal symptoms will be the price for such relief in 38 per cent of the patients. With reduction of the dosage to between 600 and 700 milligram hours, the incidence of these distressing symptoms is reduced one-half, yet the bleeding is controlled satisfactorily in but 10 per cent less than with the larger dosage.

Twenty-seven patients were between 50 and 60 and in this group the results come nearest to the ideal. The low incidence of severe menopausal symptoms as compared with that of the preceding decade is a striking feature of this age.

COMPLICATIONS

Of the 391 patients treated, 1 died from Vincent's angina 7 days after irradiation. Two others developed a pelvic cellulitis with abscess formation in 1 and both recovered. The only other complication noted was femoral phlebitis in 1 patient. This low incidence of mortality and morbidity is a strong argument in favor of radium therapy. As to remote developments, a rectal ulcer was ascribed to irradiation in 1 and a second patient, 21 years

TABLE VII.—ANALYSIS OF THE 20–30 YEAR GROUP BASED UPON INITIAL DOSAGE AND RESULTS

Dosage mgm. hrs.	Bleeding controlled, per cent	Permanent amenorrhœa, per cent	Severe menopausal symptoms, per cent
2–300	63	0	4
4–500	88	0	0

TABLE VIII.—ANALYSIS OF THE 30–40 YEAR GROUP BASED UPON INITIAL DOSAGE AND RESULTS

Dosage mgm. hrs.	Bleeding controlled, per cent	Permanent amenorrhœa, per cent	Severe menopausal symptoms, per cent
2–300	80	0	0
4–500	87	12	17
6–700	100	22	24
8–1200	95	56	47

of age, developed carcinoma of the fundus 3½ years after the primary irradiation at which time the curettings showed hyperplasia.

DEDUCTIONS FROM OUR STUDY

The ultimate purpose of a study such as this is to obtain data upon which comparison with other forms of treatment can be made, and we shall apply the results of this analysis to that end. A discussion of medical and hormonal therapy in functional bleeding is not within the province of this paper, we have previously referred to curettage and roentgen therapy, thus leaving for comparison hysterectomy with conservation of the ovaries and radium therapy.

Although uterine bleeding is the only symptom presented for relief, its control is by no means the sole standard by which to gauge the efficiency of a given method of treatment. Were it so, either hysterectomy or irradiation could accomplish the purpose equally well. Disturbance in function must be taken into consideration, indeed this is, in large measure, the determining factor in judging the efficiency of either method of treatment.

With this conception constantly in mind, we have reviewed our results in radium therapy. We have reported a morbidity of 0.76 per cent and 1 death for which the method could not be held responsible. Hysterectomy has not been performed by us in a sufficient number of patients with functional bleeding to permit of comparison, but we know our results from hysterectomy with ovarian conservation in uncomplicated myoma in which the nature of the operation and the condition of the ovaries are identical. Hysterectomy will give a morbidity of approximately 10 per cent and a mortality of 0.5 per cent. Even with ovarian conservation, severe menopausal symptoms will occur in about 7 per cent; when the uterus has been amputated sufficiently high to permit of menstruation, the menopausal symptoms are largely eliminated. With hysterectomy, the reproductive function is lost and the onset of the menopause will be earlier than normal.

Since the occurrence of severe menopausal symptoms will be stressed in this comparison, a word concerning them is in order. Because of their frequency and severity, they constitute the most formidable objection to irradiation. For some reason we are unable to explain, the symptoms are more intense and more persistent in the irradiation menopause than in the surgical.

With these facts in mind, the relative value of radium therapy and hysterectomy will be considered during each decade.

With radium therapy in women up to 30 years of age, menstruation was restored to normal or nearly normal in 88 per cent, permanent amenorrhœa developed in 6 per cent and severe menopausal symptoms in 8 per cent. One patient developed phlebitis and 1 died from Vincent's angina. Of the 40 married women in this group, 5 gave birth to normal babies and 8 had miscarriages subsequent to their irradiation. The evidence in favor of radium therapy at this age is so apparent as to make further discussion unnecessary.

Between 30 and 40 the picture changes. Although the bleeding was controlled in 95 per cent, permanent amenorrhœa developed in 24 per cent and severe menopausal symptoms in 21 per cent; this occurred at an age when preservation of ovarian function is of vital importance. Our analysis shows that increased susceptibility to irradiation begins after 30 and gradually increases, reaching its

TABLE IX.—ANALYSIS OF THE 40–50 YEAR GROUP BASED UPON INITIAL DOSAGE AND RESULTS

Dosage mgm. hrs.	Bleeding controlled, per cent	Permanent amenorrhœa, per cent	Severe menopausal symptoms, per cent
4–500	86	57	31
6–700	87	62	19
8–1200	97	92	38

TABLE X.—ANALYSIS OF THE 50–60 YEAR GROUP BASED UPON INITIAL DOSAGE AND RESULTS

Dosage mgm. hrs.	Bleeding controlled, per cent	Permanent amenorrhœa, per cent	Severe menopausal symptoms, per cent
6–700	100	77	0
8–1200	90	90	6

height in patients who continue to menstruate after 50. Further, that the incidence of permanent amenorrhœa and severe menopausal symptoms is parallel until 40 when, as amenorrhœa increases, severe menopausal symptoms decrease. These facts are of importance in this age group because of their bearing upon the selection of dosage in case re-radiation becomes necessary. We have found that with an initial dosage of between 200 and 300 milligram hours, the bleeding is controlled in 80 per cent with no permanent amenorrhœa and no severe menopausal symptoms. With gradual increase in dosage, there is a rapid increase in the menopausal reactions until, with 800 to 1,200 milligram hours, permanent amenorrhœa occurred in 56 per cent and severe menopausal symptoms in 47 per cent.

In fairness to radium therapy, let us analyze the initial dosage in this group. We find that the average dosage was much larger than it should have been and the conclusion is warranted that these unsatisfactory results are due not so much to the fault of the method as to its application.

In this group, 70 married women gave birth to 6 normal babies and 4 miscarried. Two patients developed a pelvic cellulitis, 1 going on to suppuration, and there were no deaths.

We believe that with a reduction of the initial dosage to 300 milligram hours and an increase of not more than 100 milligram hours, in case re-radiation becomes necessary, radium therapy is the method of choice in this group. Should this fail, we favor operation with preservation of ovarian function rather than increased irradiation.

Functional bleeding occurs most frequently between 40 and 50 years of age and because these women are approaching the time when, in the normal course of events, functional activity will cease, the administration of a menopausal dosage of radium has come into common usage. Our results show that with such an initial dosage, bleeding will be controlled in 97 per cent but with a severe menopausal reaction of 38 per cent. Reduction of the dosage to from 600 to 700 milligram hours will control the bleeding in 87 per cent and bring the incidence of menopausal symptoms down to 19 per cent. A 400 to 500 milligram hour dosage gives practically identical results so far as control of bleeding and permanent amenorrhœa are concerned. As previously stated, its increased incidence of severe menopausal symptoms can be discounted in favor of that shown in the higher dosage group.

We do not know the incidence of severe menopausal symptoms under normal conditions but it probably lies between 5 and 10 per cent; with an 800 to 1,200 milligram hour dosage, the bleeding will be controlled in 97 per cent but, as the direct result of this treatment, the nervous stability will be seriously impaired in one-fourth of these women who would otherwise have escaped it. With a dosage of from 600 to 700 milligram hours, the incidence of severe menopausal reactions is reduced to 19 per cent but this, too, is high. Our experience with a maximum dosage of 400 milligram hours is not sufficient to warrant conclusions, but the evidence indicates that it would still further lessen the incidence of these reactions and at the same time control the bleeding in over 80 per cent.

So impressed are we by the results of this study that we propose to give the 400 milligram hour dosage a trial in women near 40 years of age. Should this and a re-radiation dosage of 500 milligram hours fail we believe operation should be considered because in the end, it is a more conservative measure than

increased irradiation. In women near 50, increased radium dosage or roentgen therapy can be used because the incidence of severe menopausal symptoms will more nearly approximate that of the uninduced menopause.

Between 50 and 60 years of age the results of radium therapy approach perfection. Maximum dosage can be given almost with impunity since severe menopausal reactions develop in but 3 per cent.

Based upon this study, certain general conclusions seem warranted. The value of radium therapy must be measured not only in terms of bleeding control but also of the menopausal reactions which are produced by it. The deductions afforded by this study regarding these factors during the different decades and from graduated radium dosage, might be modified to some extent by a similar study of larger groups, but sufficient evidence is offered to prove the value of small initial dosage up to 50 years of age and the dangers of large dosage. When other measures have failed to control functional bleeding, radium therapy is the best method at our command, but it has its limitations and should not be used to the exclusion of operation when these limitations have been reached.

MEDICINE AND SURGERY IN INDUSTRY[1]

FREDERIC A. BESLEY, M.D., F.A.C.S., WAUKEGAN, ILLINOIS
Chairman, Board on Industrial Medicine and Traumatic Surgery

IT is axiomatic that the value of the individual to society depends largely upon his health, freedom from disabilities, and his feeling of security in the knowledge that death is postponable.

When attempting to elucidate this complex and involved subject of medicine and surgery in industry, one is confronted with his narrow limitations. We have sufficient knowledge to clarify this situation theoretically, but have we the necessary practical wisdom to utilize this knowledge intelligently in bringing about a solution of some of the vital problems?

Several years ago Dr. Franklin H. Martin, director general of the American College of Surgeons, observed that "the subject is a most important one and someone must do something about it." With his characteristic vision, his courage, and his prompt action he established a Board, the function of which was to make an accurate, comprehensive, and complete study of the entire subject of industrial medicine and traumatic surgery, that the knowledge so gained might aid us in wise and judicial decisions for the betterment of all the involved interests. During the past year he has sent two excellently trained men into the field for the purpose of making a first hand, fact finding study of the activities of industrial clinics in all their medical, surgical, and economic aspects. Some of the data thus secured might have been ascertained from information and statistics previously compiled, and yet, as a basis for the formulation of a definite proposed plan and program, there is no knowledge so valuable as that obtained by a first hand survey.

Upon the data thus secured it is proposed to approve such medical set-ups in industry as shall conform to the minimum standard for such departments, as it has been established by the College.

As a preamble in the consideration of the problems involved in industrial medicine, three essential basic principles present themselves.

First, the health, happiness, efficiency, and general mental and physical welfare of the employee. This is the paramount object.

Second, the protection of the rights and the ethical standards of the physicians in their relation to the worker in industry. All of these principles must be safeguarded.

Third, the direct and indirect economic saving that will accrue to the employer, the employee, and to society at large if intelligent, scientific, surgical, and medical care is given to the employees and their families.

Is there any conflict of interest in a joint consideration of these principles? In this rapidly changing era of our present day civilization, has the time arrived when these stated principles must be intelligently considered and plans perfected for their more effective application? There is no paradox in such a consideration and the community of interests demands that thought be devoted to it.

During the past few years a vast amount of literature has appeared in the medical and lay press relative to the alleged high cost of medical care and hospitalization. Extensive surveys have been made and comprehensive data secured and tabulated on this subject. There appears to be a popular psychology and a generally accepted opinion that these costs are too high. Will a careful and accurate analysis of this whole situation confirm this opinion? We believe it will not and that it is a debatable question.

Apparently what has happened is that the present extent and cost of the means and the methods employed in arriving at an accurate scientific diagnosis and the applying of the proper therapeutic measures to the sick and injured patient have evolved and increased beyond the ability of the average patient with an average income to pay this medical expense as an individual. Will it be possible to formulate and to put into execution some plan or program whereby this ever increasing cost can be met by society in some collective arrangement? Is this the crux of the problem?

[1]Oration in Industrial Medicine and Surgery, presented before the Clinical Congress of the American College of Surgeons, October 17–21, 1932.

No one will agree with the thought that the scientific methods now employed should be abandoned or curtailed, or that all of the people in all walks of life should not enjoy the benefits of the best in medicine and surgery. All the sick are not receiving adequate care under present conditions: our present system of caring for the sick and injured leaves much to be desired. The value of health welfare of workers in industry, in a community, in a municipality, in a state, in a nation, transcends any other consideration.

Complete examinations of the men made during the drafts for the army in the late war revealed that large numbers, approximately one-third, were wholly unfit for duty. Similar examinations made of the men now engaged in the army of industry would show a greater proportion of unfit and handicapped.

Are proper remedial measures being taken by industry to correct this unfortunate condition? No! How simple the logic and the deduction that no organization can be stronger and more efficient than the individuals that compose it. The measure of the constructive work that has been done for the health of employees in industry during the past few decades is the condition of their health at the present time as compared to the past. There may have been some improvement, but certainly that improvement is infinitesimal. Organized medicine has an unalterable duty in exerting every effort to evolve a far seeing plan to remedy existing conditions and to employ every known method in an attempt to improve the health welfare of employees in industry

What of this whole situation as it relates to the material self interests of the physician about which there is so much discussion at the present time?

During the past few decades industrialists have made an effort to establish medical departments in their industries and as a result of this activity there came into existence the name "industrial surgeon," to designate the physician who assumes the administration of these departments. Unfortunately, in the earlier years some criticism arose of the ethical methods of these men because they were considered contract surgeons and it was reasoned that they employed unfair methods in competition with their fellow practitioners. Fortunately, some of this has passed and it is now recognized that many of these industrial surgeons had broad, far reaching vision and that they were worthy pioneers in the advancement and promotion of better medicine and surgery as it pertains to the worker in industry.

It is within the scope of discretion to venture the opinion that the fellows of the American College of Surgeons have been ignorant of the potentialities in industrial medicine and surgery. Bias and prejudice have played a large part in this indifference. This attitude is changing and a keen interest is developing rapidly in all phases of industrial medicine. Obviously there can be no advancement made in medicine unless the material interests of the profession are protected and conserved, and this must not be forgotten in any thought of medicine and surgery in industry.

Can not some plan be promoted whereby all the physicians in any industrial community may profit by and partake in any and all of the activities in medicine and surgery that industrialists may be stimulated and inspired to initiate? We believe it can, and one concrete suggestion occurs to us. Given a community in which there may be several small, or one large industry, it should be possible and feasible to induce the executives of industry to subsidize and partly support a semi-public diagnostic clinic to which all of the physicians of this locality should have access and where all patients might receive the advantages of trained technicians and complete laboratory examinations. This at a cost within the reach of all. Naturally this would result in an advantage to the patient, the physician, and incidentally the industrialists would profit financially to an extent that is difficult to estimate or overstate.

Think of the vast, if intangible, financial gain that would accrue to industry if any given industrial community could be made healthier and the health welfare and happiness of that area conserved and protected. Again it is not possible to estimate accurately the increased working power of the men under such a condition.

This is but one of the many arrangements that could be put into effect adding to the profit of the physician in financial gain and educational advancement.

Is it not the unquestioned duty and privilege of the fellows of the American College of Surgeons to become vitally interested in this subject of medicine and surgery in industry and to pursue a study of the entire situation so that a solution of some of the problems may be arrived at through the combined opinion, judgment, and effort of the carefully selected men composing this great organization. The measure of the success of any of the proposed solutions of the mooted questions in the situation of medicine and surgery in industry can be expressed in terms of the advantages that will accrue to the worker, the physician, and to industry.

How will leaders of industry benefit and how can we as physicians secure the largest measure of co-operation from these leaders in any proposed plan for better medical and surgical care for the employee?

No appeal should be made to these executives on the basis of philanthropy nor should there be an appeal to capitalistic greed, but the appeal should be made on sound financial judgment and business sense which will demonstrate an advantage and profit to all branches of society. In the past there has been a tendency in industry to devote a disproportionate amount of thought and capital to the care of the injured rather than to the sick or handicapped worker. The magnificent work of the National Safety Council has resulted in such an enormous decrease in industrial accidents that there is an ever declining necessity for surgery in industry. How much larger and more important is the field of medicine as it applies to industrial relationships.

Some of the larger industrial organizations have a most efficient and effective medical department and have achieved striking results from their activities. It is to be noted, however, that only a small percentage of all employees are engaged in organizations employing five hundred or more men. Data taken from the United States Bureau of Census report 1929, shows the following: over 95,000 plants employed 1 to 5 persons each; 194,206 plants employed 1 to 100 persons each. The total number of wage earners employed in these plants is 2,581,578 and it is safe to say that a vast number of employees in these smaller plants receive no medical supervision as a group or that the care provided is entirely inadequate.

A word about some of the practices now employed may be constructive. In many plants, particularly the smaller ones, the medical department consists of a few dressings and drugs and possibly a separate room known as the first aid station. If such an arrangement is under the control of a competent surgeon, it may serve a useful purpose but all too often it is presided over by an untrained, unskilled fellow employee, not even a trained nurse being employed. The statement that such a plan is a vicious practice cannot be controverted. Under such conditions attempts are frequently made by these unskilled people to remove foreign bodies from the eye which are imbedded in the cornea, or another common procedure is the unsuccessful effort to remove a splinter of wood from beneath a finger nail. Corneal ulcers and infected fingers are the result, with the subsequent loss of an eye, a finger, or a hand. Trained nurses in charge of these so called dressing stations who are not controlled by a competent medical adviser are of questionable value.

One of the worst influences that has grown up in the medical departments of industry and in the contacts with insurance companies in workmen's compensation cases is the interference by the personnel man at the plant and the claim agent in insurance. These men all too frequently dominate the situation and control any and all medical activities. Their motive is prompted by the narrow minded desire for immediate financial gain.

This condition of affairs must be combated and changed if advancement is to be accomplished. Until the late war, a similar condition existed in fighting armies. The general staff officers were in supreme control of the welfare and disposition of the soldiers. The medical officer was relegated to the subordinate position of caring for the sick and

wounded, controlled, of course, by the general staff officer. The medical officer had no voice in the location of a camp or base area and often his comments or advice as to water and food supply went unheeded. The staff officer was interested, as he thought, only in the man at the front fit for duty. The sick and wounded were not his vital concern.

Think back to the time of the occurrence of typhoid fever, dysentery, tetanus, and the scandal regarding the food supply that existed during the Spanish American War. The Civil War, Boer War, and previous wars all had similar difficulties. All this was changed during the World War. It was recognized early in the conflict that victory would depend upon man power as measured in terms of numbers, morale, and health welfare. The wise leaders and administrators immediately conceived the plan of securing the best and most scientific medical and surgical talent that was available and of giving these men sufficient authority to direct and control the health welfare of the troops. The medical profession came into its own.

What was the result? No typhoid, no dysentery, no tetanus, and the morale of whole armies raised by the knowledge that if injured, they would receive the most prompt, skillful, scientific, surgical care possible.

You are all familiar with the excellent medical organization in our own army. The untiring efforts and administrative and executive ability of General Gorgas and Dr. Franklin H. Martin, our own director general, were responsible for the securing of the loyal support of all branches of the country's medical activities. The Secretary of War, Newton D. Baker, had a sympathetic understanding of the requirements and gave his unqualified approval to the recommendations of these men. This is a matter of historic record. The benefits derived from such an organization, in the preservation of the health of the men in the army and in the skillful care given to them when wounded, cannot be overestimated.

Can the circumstances and conditions involved in considering the effectiveness of an army of soldiers equipped for war be compared to those of the peace time army of industry?

Are the great captains of industry assuming the same attitude toward the medical profession that was formerly assumed by the general staff officers toward the army medical corps?

If these questions can be answered in the affirmative, and we believe they can, then it is our unqualified duty to elicit the support of every medical man in conceiving and executing a remedial plan. Great industrialists are intelligent leaders who are amenable to logic and reason. It should not be difficult with the accurate and extensive statistics that are now available to convince these men of the financial advantages and profit that will accrue to their stockholders if the health welfare of their employees can be conserved and improved.

It is conservatively estimated that 360,000,000 working days are lost to industry through disabilities due to sickness, or at a rate of $3.00 per day, over $1,000,000,000 (one billion dollars) are lost yearly from illness!

Nearly all large industries are, at the present time, spending vast sums of money in what is known as their research departments and yet the results from the expenditures of these millions are frequently not immediately evident or tangible. Should it be difficult to convince the executives of industry of the large financial advantages of maintaining a research medical and surgical department to study methods and means for improving the health of their employees? It is our conception that a united effort on the part of the medical profession in collecting data on this subject would result in securing the most convincing evidence with which to demonstrate that the establishment of a health research department in all large industries would result in an enormous economic saving to the employer. The employee and society at large would most certainly profit. Consider one concrete condition, the so called ordinary cold. Try to imagine how much economic waste occurs from this prevalent infliction, resulting in labor turnover and in rearrangement and shifting that must occur within any given department when employees are absent or at work and not functioning efficiently. How many times this concrete example could be repeated by citing other health conditions.

It is recognized that only the social and economic aspects of medicine and surgery in industry have been presented. The assumption is that the fellows of the American College of Surgeons are well versed in the professional phase of this all important situation.

Leaders in any human accomplishment are men of character, men with ambition, men with vision, men with courage, and men endowed with the untiring energy and persistent application to the work necessary in their efforts to achieve their desired end. Such leaders constitute the selected membership in this organization. You, fellows of the American College of Surgeons, are leaders of influence in your respective communities. We appeal to you to go back home and exercise that leadership. Become representatives of the College in your daily contacts with industrialists large and small, and sell to them a far seeing program for the standardization and rationalization of better medicine and surgery in industry.

Such a program proposes and comprises the following:

1. The education of the industrialists so that they will come to recognize the financial saving and gain that will be shown by increased profits and dividends if their human machinery can be made to function more efficiently because of better health and strength.

2. To carry the thought to organized medicine that their self interests, both immediate and remote, will be conserved and enhanced with the establishment of proper medical and surgical departments in industry, controlled and regulated by the leaders in the medical profession so that their financial remuneration and ethical standards shall be maintained.

3. The employee, whose welfare is the paramount issue, needs no further education or convincing, for he understands that he will be the beneficiary. Organized labor is already committed to such a plan. The American College of Surgeons pledges itself to the promotion of such a plan.

May we say to each and every one of you that this is your opportunity and the responsibility for the success of such an undertaking is yours.

FRACTURES AND DISLOCATIONS IN THE REGION OF THE ELBOW[1]

PHILIP D. WILSON, M.D., F.A.C.S., BOSTON
From the Fracture Service, Massachusetts General Hospital

FRACTURES and dislocations in the region of the elbow are extremely common, and on account of the toll of deformities and disabilities they have levied in the past have won a reputation for formidableness that is scarcely equalled. Although much has been written about these injuries, there still remain sufficient gaps in our knowledge to justify further study of them. It will be our purpose in this article to present a more or less comprehensive view of all the different lesions that are designated by the title "Fractures and Dislocations of the Elbow." Many of the injuries are multiple, and it is only by including all in the study that an accurate picture can be presented of the whole.

For the purpose of gathering material we have reviewed the records of 352 patients with 439 fractures or dislocations of the elbow that have been treated by the staff of the fracture service of the Massachusetts General Hospital between the years 1924 and 1930, inclusively. Of these, 174 patients with 213 injuries about the elbow were treated as in patients, and have been carefully studied and followed. End-result clinical and X-ray examinations have been made at a period longer than 1 year after discharge from the hospital in 140 patients with 176 elbow injuries, representing 82 per cent of all the house cases. The other patients were treated in the emergency ward and out patient department of the hospital. For the most part their injuries were of less severe type so that hospital admission was not considered necessary. The records of these patients are incomplete, and contain notes only of the diagnosis and treatment at the time of the first visit. These have been used chiefly for statistical purposes in order to give as complete a picture as possible of the entire problem. During the 7 year period covered by the study the total number of patients with fractures and dislocations treated in all departments of the hospital was 4,066, and the total number of skeletal injuries was 4,536 so that the fractures and dislocations of the elbow represented approximately 10 per cent of the entire group.

A word of explanation is necessary in respect to the system of grading end-results that is employed at the Massachusetts General Hospital. The result is evaluated from three standpoints, A (anatomic), F (functional), and E (economic), and is expressed by numbers ranging from 0 to 4, the former representing the minimum and the latter the maximum. Considerable latitude is permitted by the numbers, 1 representing from 0 to 25 per cent, 2 from 25 to 50 per cent, 3 from 50 to 75 per cent, and 4 from 75 to 100 per cent. "Anatomic" refers to bony alignment, and is determined from the X-ray; "functional" takes into consideration the range of joint motion, muscular strength, and the presence or absence of pain; while "economic" refers to working and earning ability. For example, A_3 F_4 E_4 means that the X-ray shows slight bony deformity, but that functionally the patient is practically normal, and that he is able to do the same work and earn the same wage as before injury. A_1 F_2 E_3 indicates less than 25 per cent of normal alignment, less than half of the normal motion, and only about 75 per cent of the previous earning power.

Types of injury. It is important to make an accurate diagnosis of the exact type of fracture or dislocation of the elbow as the methods of treatment are different, and each carries its own particular dangers. Many of the unsatisfactory results that are seen after injuries of the elbow are the result of failure to distinguish between the different types and the attempt to treat all without distinction by one common method.

Epiphyses. The lower end of the humerus lacks a single common epiphysis similar to that at its upper end or to those at the ends of the radius, femur, and tibia. Instead, ossification proceeds from several distinct epiphyseal centers which unite with the shaft at different age periods. Any of these epiphyses, such as the capitellum or medial epicondyle,

[1]Oration on Fractures, presented at the meeting of the Clinical Congress of the American College of Surgeons, St. Louis, October 17–21, 1932.

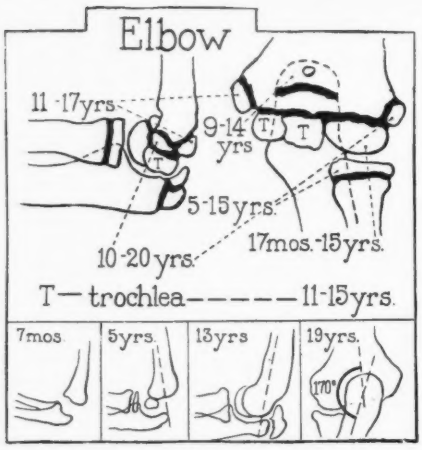

Fig. 1. Diagram showing ossification of the epiphysis of the elbow. (From Camp and Cilley. Am. J. Roentgenol. 1931, xxvi, Dec.)

may become separated as a result of trauma during the period when it is vulnerable, but epiphyseal fracture of the entire lower end of the humerus almost never occurs, and no single instance of it was found in our series. A knowledge of the normal X-ray appearance of the epiphyses and of the age at which they unite is essential for the proper treatment of fractures (Fig. 1).

TABLE I.—GRAND SUMMARY SHEET

	House cases			Emergency ward		
	Number	Per cent	Results	Cases	Total	Per cent
Supracondylar	57	.267	46	25	82	.19
Medial epicondyle	14	.065	12	22	36	.082
External condyle	6	.028	6	14	20	.046
Internal condyle	5	.023	3	11	16	.036
Intercondylar	12	.056	12	2	14	.032
Capitellar epiphysis	10	.046	8	1	11	.025
Lateral epicondyle	0	.0	0	7	7	.016
Fracture of capitellum	3	.014	3	0	3	.007
Total lower end humerus	107	.502	90	82	189	.433
Head and neck radius	30	.141	24	45	75	.17
Olecranon	33	.155	25	28	61	.14
Coronoid	7	.032	6	8	15	.036
Upper end ulna into joint	3	.014	3	0	3	.007
Total fractures	180	.85	148	163	343	.78
Anterior dislocation radial head	3	.014	3	0	3	.007
Dislocations	30	.14	25	63	93	.21
Total injuries	213	100	176	226	439	100

Frequency of the various injuries. The relative frequency of the different types of fractures and dislocations about the elbow is shown in Table I. The most common injuries in order of frequency were first, dislocations; second, supracondylar fractures; third, fractures of the head and neck of the radius; fourth, fractures of the olecranon process.

Multiple injuries. Many of the skeletal injuries about the elbow are multiple. This is particularly true of the dislocations which are frequently accompanied by fractures and of the fractures of the olecranon, upper extremity of the radius, coronoid process, and medial epicondyle, which are often associated with other injuries either fractures or dislocations. The incidence of the complicating injuries in respect to the various fractures and dislocations of the elbow is shown in Table II.

Nerve injuries. Injury of one of the main nerves of the arm complicated the fracture or dislocation in 9, or 5 per cent, of the 174 house patients. All of these injuries were of the nature either of contusions or stretching of the nerve, and spontaneous recovery occurred in every instance. The various lesions are shown in Table III.

Age distribution. It may be seen from the graph (Fig. 2) that fractures and dislocations of the elbow occur with the greatest frequency among children; actually 101, or 58 per cent, of the house patients were under 15 years of age. This fact should prove a stimulus to the surgeon because childhood is the most favorable age for recovery from skeletal injuries, and on that account failure to avoid functional impairment seems doubly tragic.

I. SUPRACONDYLAR FRACTURES OF THE HUMERUS

The supracondylar fractures were numerically the most frequent of the injuries in the region of the elbow, and constituted 19 per cent of our group of cases. The incidence was highest in childhood, and 92 per cent of the patients were under 15 years of age, and 84 per cent below the age of 10. There seemed to

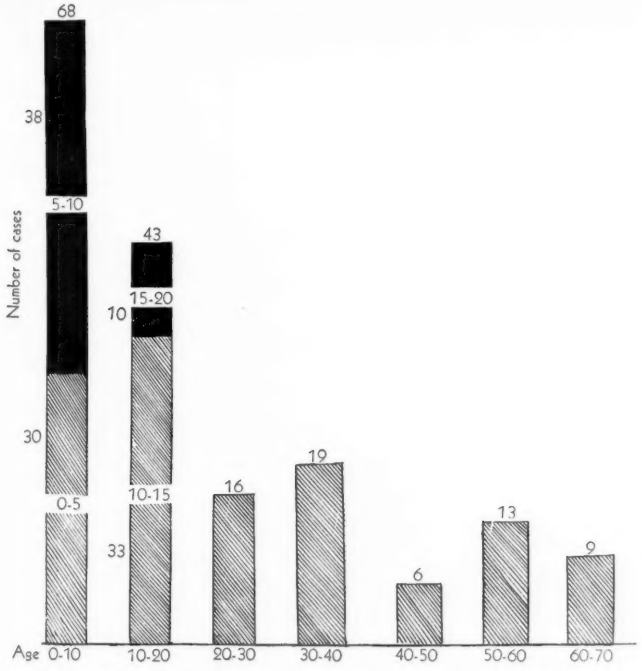

Fig. 2. All injuries of the elbow (174 house patients). Age distribution by decades.

be an extraordinary resistance to this injury in adult life judging by the absence of any instance of it between the ages of 20 and 50 years. It was re-encountered in the elderly group, and 4 of our patients were in the sixth decade (Fig. 3).

The fracture is more accurately described as diacondylar than supracondylar, but since the latter term is better known, it will be retained. The fracture line passes transversely through the upper part of the condyles instead of above them, and in the lateral plane it slopes obliquely downward and forward. It is usually produced by a fall on the outstretched hand with backward and upward thrust on the forearm. The lower fragment is displaced backward, and the lower end of the upper fragment

TABLE II.—COMPLICATING INJURIES OF ELBOW FRACTURES

	Cases	Multiple injuries of elbow Cases	Multiple injuries of elbow Per cent	Fracture elsewhere Cases
Supracondylar	82	2	2.4	4
Medial epicondyle	36	15	42	1
Lateral epicondyle	7	2	28	–
Condylar fracture	50	4	8	3
Dislocation of elbow	93	56	60	4
Head and neck of radius	72	17	23	5
Olecranon	61	15	24	6
Coronoid (E.W.)	15	12	80	1
Capitellar epiphysis	11	1	9	0
Capitellum	3	2	66	1

TABLE III.—NERVE INJURIES

Nerve	Primary lesions	Secondary lesions	Total
Radial	2	2	4
Ulnar	5	0	5
Median	0	0	0
			9
Radial nerve			
Intercondylar fracture of humerus			1
Supracondylar fracture of humerus (1 post-reduction)			2
Fracture head and neck of radius (post operative)			1
Ulnar nerve			
Dislocations of elbow with fracture of medial epicondyle			4
Comminuted fracture of olecranon and upper ulna			1

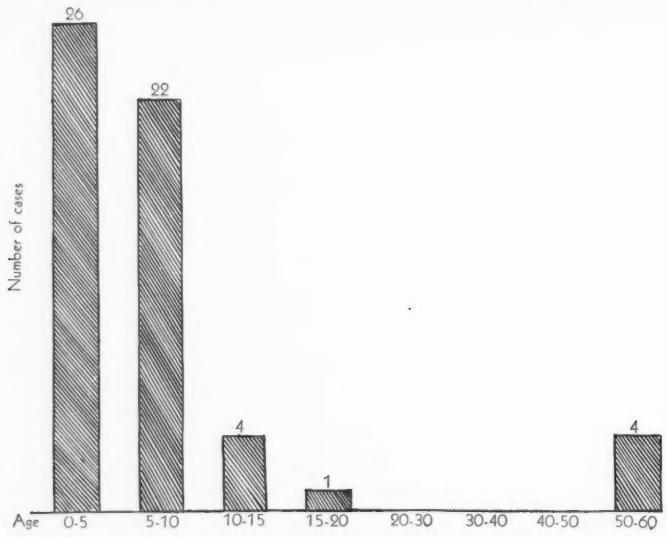

Fig. 3. Supracondylar fractures (57 house patients). Age distribution by decades.

comes to lie anteriorly and medially in close relation to the brachial vessels. Occasionally it escapes through the skin producing an open or compound fracture. In the group of patients (57) studied there were two with compound fractures, or an incidence of 3½ per cent.

The flexion type of supracondylar fracture, although rare (3 examples in 57 cases, or 5 per cent), needs to be distinguished from the common hyperextension type of fracture. It generally results from a fall on the flexed elbow and the deformity is reversed, the lower fragment being displaced forward instead of backward. Closed reduction is brought about by extension of the elbow instead of by flexion and, if correction is obtained, splints should be applied with the elbow in this position. The deformity is generally increased by the position of acute flexion. In the group of patients studied, there were 3 examples of this type of fracture. Two were adults and one a child. Open reduction was necessary in the two former, and closed reduction was satisfactory in the latter.

In the common type of supracondylar fracture when the patient is seen within a few hours of the injury, reduction can generally be accomplished by the manipulative method and the correction maintained by the position of acute flexion of the elbow. It needs to be emphasized that the position of acute flexion is not a means of reducing the fracture but of retaining alignment after reduction has been accomplished. Reduction may be performed as follows: with the patient anæsthetized and an assistant making countertraction on the upper arm, traction should be exerted on the forearm, the elbow being extended. The elbow should be drawn downward and rotary displacement corrected. The lower fragment should then be pushed forward and the elbow slowly flexed. If the reduction is performed within a few hours of the injury before there is any vascular interference from swelling, and if the replacement is complete, it will be possible to bring the elbow into a position of complete hyperflexion without obstructing the radial pulse, and it should then be fixed in that position either by the application of a snug bandage or by a molded posterior plaster splint. Retention by a circular strip of adhesive plaster, in our opinion, is dangerous and likely to interfere with the circulation.

Ischæmia. The great menace of the supracondylar fractures is much more from vascular

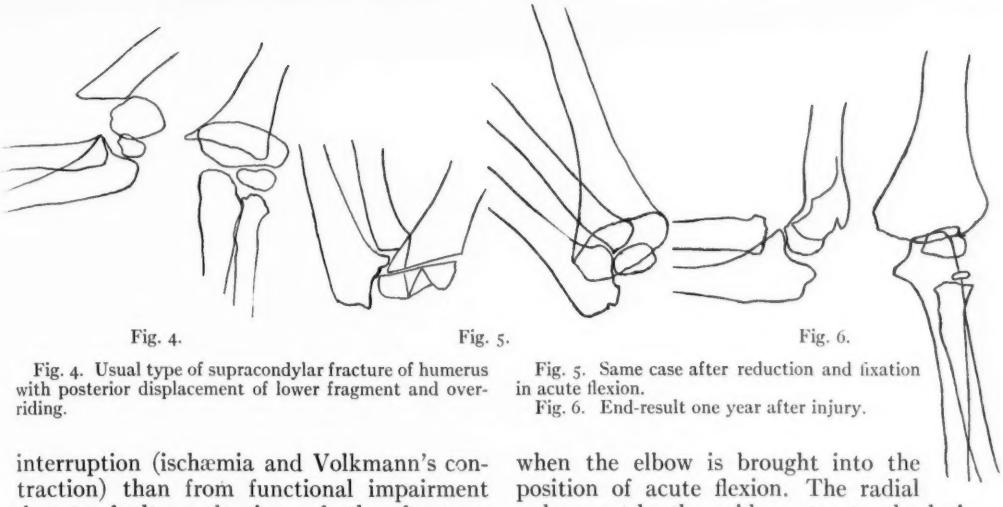

Fig. 4. Fig. 5. Fig. 6.

Fig. 4. Usual type of supracondylar fracture of humerus with posterior displacement of lower fragment and overriding.

Fig. 5. Same case after reduction and fixation in acute flexion.

Fig. 6. End-result one year after injury.

interruption (ischæmia and Volkmann's contraction) than from functional impairment due to faulty reduction of the fracture. Ischæmia, that dreadful complication, often equivalent to total loss of the arm, is ever imminent, and this danger must always be kept in mind. While in most instances it is a consequence of the injury rather than of the treatment, and may develop in the complete absence of all constrictive dressings, there is little doubt that failure to recognize it when impending, and therefore to take all needful steps to prevent or check it, may make a great deal of difference in respect to the amount of function that may be saved. Examination should never be confined to the region of the fracture, but should include the entire extremity and tests of the circulation, cutaneous sensibility, and motor power of the hand and wrist should always be made.

Absence of the radial pulse, pallor and coldness of the hand, inability to flex or extend the fingers, and loss of cutaneous sensibility are the signs of fully developed ischæmia, and, in our opinion, demand immediate operative intervention as will be described later. But it is equally necessary to recognize the signs of incomplete circulatory disturbance, and in that case to adopt a plan of treatment that will take into account both the needs of the fracture and those of the circulation as well. By these signs I refer to the presence of marked swelling about the elbow, cyanosis of the forearm and, above all, to interruption of the radial pulse when the elbow is brought into the position of acute flexion. The radial pulse must be the guide post not only during the reduction of the fracture but also throughout the immediate after-treatment and must always be carefully watched. Disappearance of the radial pulse while the elbow is being flexed following the reduction of the fracture is a sign either of incomplete reduction or of such great extravasation into the soft parts and infiltration of the tissues that the brachial artery becomes compressed as a result of the postural tension. In either case, it is an indication for the return of the elbow to a position in which the radial pulsation can again be felt, and for the application of splints in that position to maintain the best alignment possible. When the circulatory balance is particularly bad, it may be the part of wisdom to abandon all attempts at reduction for the moment, and instead to concentrate on improving the circulation by such measures as elevation, application of radiant heat, and even operative intervention, if indicated. After a few days, when the swelling has subsided, a second attempt at closed reduction may be made, or open reduction may be performed. An alternative method that has given successful results is the application of skeletal traction from an overhead frame by means of a Kirschner's wire inserted in the olecranon process. This obtains reduction of the fracture, permits the elbow to assume the position of flexion from the unsupported weight of the forearm, and

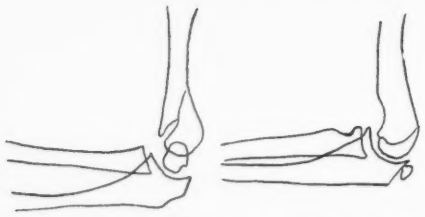

Fig. 7. A. Roentgenologic appearance of malunited supracondylar fracture of humerus three months after injury. Note: that union has taken place with the lower fragment lying posteriorly and that the lower end of the proximal fragment projects anteriorly and appears to block flexion. B. Same elbow three years later showing correction of deformity by process of growth.

at the same time secures elevation and relieves swelling.

Frank, established ischæmia requires immediate operative intervention. Let no one depend upon closed reduction of the fracture as a means of relieving pressure upon the vessels. Our own tragic experience with 2 patients shows the futility of this method (see Table IV). On the other hand, gratifying results were obtained in 2 patients by incision along the inner side of the elbow, evacuation of the hæmatoma, and by exposure and freeing of the vessels. In one case the latter were found twisted about the upper fragment and the pulsation immediately returned upon freeing them. This experience was particularly encouraging, and holds out hope that by immediate operation in the early stage Volkmann's ischæmic contraction can be prevented either completely or partially. Ischæmia developed in 5 of our 82 patients, or 6 per cent. Data concerning these patients is shown in Table IV.

Vascular disturbance of greater or lesser degree was present in a large proportion of the patients studied, and in these the treatment of the fracture was made secondary to safeguarding the circulation. In 22 of our 57 house patients more than one closed reduction was performed. This was usually due to the fact that the radial pulse was shut off by the position of acute flexion of the elbow, and that correction could not be maintained with the elbow in a less favorable position. Open reduction was performed in 11 cases. Five of these operations were necessitated by failure of closed reduction, 1 was in a compound fracture where open reduction was combined with immediate débridement, and the 5 remaining were in patients who were admitted late, that is, from 4 to 10 days after injury.

The treatment after either closed or open reduction consisted of immobilization for a period of about 3 weeks followed by protection in a sling for 1 or 2 weeks longer. No effort was made to employ early massage and movement. End-result examinations were made in

TABLE IV.—SUPRACONDYLAR FRACTURES WITH ISCHÆMIA—FIVE CASES OR SIX PER CENT OF EIGHTY-TWO CASES

Identification	Age	Time after injury	Examination of hand	Treatment	Result
C.H. (0.252417)	4	3 hrs. No previous treatment	Pallor, and loss of sensation and power. Absent pulse	Immediate closed reduction. Right angle flexion; elevation; heat	Volkmann's contraction. A_4 F_2 E_2
R.H. (W.265957)	8	2 hrs. No previous treatment	Pallor, loss of sensation and power. Absent pulse	Immediate closed reduction. Right angle flexion; elevation; heat	Volkmann's contraction. A_3 F_2 E_3
W.H. (W.285639)	5	6 days. Reduction performed elsewhere and elbow fixed in flexion	Hand swollen, cyanotic and tender. Loss of sensation and power. Absent pulse. Elbow swollen. Pressure sore	Splint removed, elbow extended. Elevation, heat. Closed reduction 10 days after injury. Right angle flexion	Volkmann's contraction. Neurolysis 3 mos. after injury. End-result unknown
C.R. (W.293820)	3	24 hrs. Two attempts at reduction made elsewhere	Hand swollen, cyanotic and tender. Diminished sensation. Loss of extension of fingers and wrist. Feeble radial pulse. Elbow swollen	Splint removed. Elbow extended and elevated. At end of 5 days, closed reduction. Pulse disappeared. Incision over elbow, evacuation of blood clot. No reduction. 140° extension	Slight flexion contraction of fingers. Cleared up with physical therapy. $A_2F_1E_1$
M.T. (E.278179)	5	2 hrs. No previous treatment	Hand pale. Loss of sensation and motor power. Absent radial pulse	Immediate operation. Medial incision: lower half did not bleed. Exposure and freeing of vessels found twisted about upper fragment. Fixed with elbow extended. Later, closed reduction unsuccessful	Pulse returned. No contraction. A_4 F_4 E_4

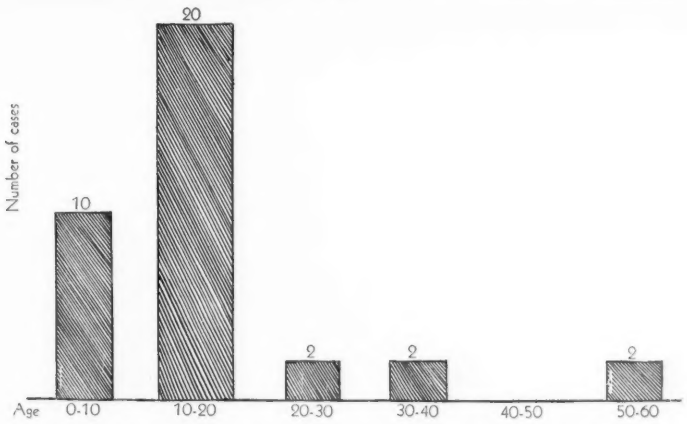

Fig. 8. Medial epicondyle fractures (36 cases). Age distribution by decades.

45 of the 57 patients more than 1 year after discharge from the hospital, and the gradings are shown in Table V. The outstanding impression from their study is the excellence of the results. They were graded excellent or good, meaning practically normal function in 37, or 82 per cent. There were 3 poor results, 2 due to ischæmia, and 1 due to gas bacillus infection developing in a patient with a compound fracture who had been treated elsewhere and in whom disarticulation of the shoulder had to be performed immediately upon admission. Five results were graded as fair, meaning some alteration of alignment and moderate limitation of elbow function. Only 3 of these were attributed to our treatment, one being a case of ischæmia, another a patient admitted only after a delay of 10 days in whom an open reduction was done, and the third the case of a patient with a compound fracture who refractured the elbow 7 months after the first injury.

It remains to be added that a considerable number of good and even excellent results were obtained even in the absence of complete reduction. Several patients with old malunion and uncorrected complete posterior displacement of the lower fragment have been followed in the fracture clinic and in the end obtained useful elbows. Bony consolidation always took place, and, although in the beginning there was an ugly deformity which seemed to block flexion of the elbow, even this was eradicated in the course of time as growth from the lower epiphysis elongated the humerus and pushed the elbow away from proximity to the point of injury. This should be remembered when dealing with fractures associated with vascular disturbance. Change in the carrying angle of the elbow was noted in some of the end-result examinations, but rarely exceeded 5 to 10 degrees, and seemed to be of little functional significance. It would seem that the alteration must be of a rather gross type if it is to constitute a handicap. The ability completely to extend the elbow was

TABLE V.—RESULTS IN SUPRACONDYLAR FRACTURES

	Total	Excellent A_4 F_4 E_4	Good A_3 or $_3$ F_4 E_4	Fair A_3 F_3 E_4	Poor	Unknown
Flexion type of fracture						
Closed reduction	1		1			
Open reduction	2		1			1
Hyperextension type of fracture						
No displacement	1	1				
Old malunion (physical therapy)	2		1	1		
Closed reduction	38	23	4		I. 2	9
Open reduction	10	3	3	2		2
Refused treatment	1			1		
Compound fractures	2			1	A. 1	
Totals	57	27	10	5	3	12

I.—Ischæmia; A.—Amputation.

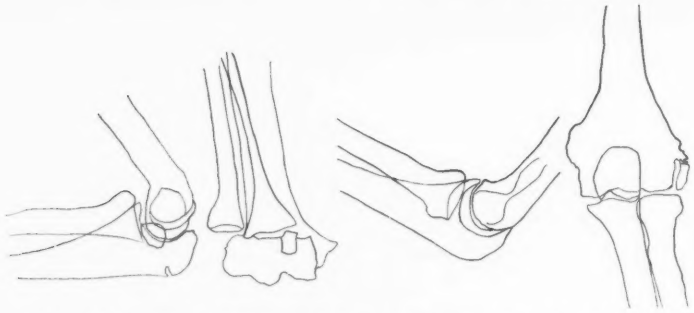

Fig. 9, left. Posterior dislocation of elbow with fracture of medial epicondyle following reduction. Note that the epicondylar fragment has been caught in the joint space. This patient had ulnar palsy.

Fig. 10. Same case as Fig. 9 showing end-result 13 months after injury. The epicondylar fragment was removed, and the patient has recovered from the ulnar nerve lesion. There is a small area of calcification in the lateral portion of the joint capsule.

recovered in almost all cases, restriction of 10 to 15 degrees being found only in a few.

II. FRACTURE OF EPICONDYLES

Fracture of the medial epicondyle is common, while fracture of the lateral epicondyle is rare. There were 36 patients with the former injury, or 8.2 per cent of the entire group, while there were only 7 instances of the latter injury (1.7 per cent) all insignificant and none requiring admission to the house. The difference in the frequency of the two injuries is accounted for by the difference in ossification of the two processes, the medial epicondyle having a large, separate center of ossification, while there is only a tiny center of ossification for the lateral epicondyle, which is well protected, and does not serve as an important point of attachment for muscles or ligaments. The epiphyseal center for the medial epicondyle appears at about the ninth year and unites from the fourteenth to the fifteenth year.

Most of the fractures affecting the medial epicondyle are in reality epiphyseal separations. This is shown by the age of the patients—of the 14 patients with this injury 13 occurred between the ages of 10 and 17 years (Fig. 8).

The medial epicondyle is most commonly fractured in association with posterolateral dislocation of the elbow, being pulled away by the attachment of the strong internal lateral ligament. This association was found in 14 of the 36 examples of this injury, or 40 per cent. The injury may be complicated by other bony injuries due to the dislocation, such as fracture of the head or neck of the radius and of the coronoid process. In the cases of fracture uncomplicated by dislocation, the injury is the result either of direct violence applied to the epicondyle or of an adduction strain of the elbow.

The treatment of fractures of the medial epicondyle is chiefly the treatment of the associated injuries, that is reduction of the dislocation if present followed by fixation of the elbow in the position of acute flexion. Nothing can be accomplished in the way of direct closed reduction of the fracture, but the position of acute flexion secures relaxation of the flexor muscles of the forearm which are attached to the epicondyle, and thus tends to bring about replacement.

No functional impairment need be anticipated following fracture of the epicondyle unless there is an accompanying dislocation. When the two occur in association the prognosis is that of the dislocation. In our group of 14 house patients of which 11 had associated dislocations, end-result examinations were made in 11. The functional results were excellent in 10, although in 3 the epicondyle had united by fibrous union only. One result was poor, but this was due to the dislocation and not to the fracture.

TABLE VI.—DISLOCATION OF THE ELBOW WITH FRACTURE OF THE MEDIAL EPICONDYLE AND DISPLACEMENT INTO THE JOINT

Identification	Age	Length of time after injury	Reduction of dislocation	Ulnar palsy	Treatment	Result
W.I.I. (O.290721)	15	Few hours	Immediate closed reduction	Complete	Excision of fragment. Transplant of ulnar nerve	A_4 F_4 E_4
G.W.M. (W.310488)	12	3 days	Dislocation reduced by outside physician	Complete	Excision of fragment. Transplant of ulnar nerve	A_4 F_4 E_4
K.L. (O.298864)	16	Few hours	Immediate closed reduction	No	Immediate operative replacement of fragment	Immediate result good. End-result not known
D.A.T. (E.283179)	16	5 months	Dislocation reduced by outside physician. Had limited elbow function	Complete	Transplantation of ulnar nerve. Nothing done to fragment	A_2 F_2 E Recovered nerve function but had limited flexion and extension of elbow
P.Z. (O.286236)	15	24 hours	Dislocation reduced by outside physician	Complete	Excision of fragment. Transplantation of ulnar nerve	A_4 F_4 E_4

II A. DISPLACEMENT OF THE MEDIAL EPICONDYLE INTO THE ELBOW JOINT WITH ULNAR PALSY

There is one complication that must always be looked for in patients with dislocation of the elbow and fracture of the medial epicondyle. This is displacement of the epicondylar fragment into the elbow joint and imprisonment of it there when the dislocation is reduced. The ulnar nerve being attached to the epicondyle is carried along with it into the joint and later becomes pinched between the articular surfaces when reduction of the dislocation is effected with resulting ulnar palsy. Usually the first warning of the presence of this complication is the appearance after reduction of the characteristic signs of ulnar nerve injury. An X-ray examination should be made, however, both before and after the reduction and in the first films the appearance of the epicondylar fragment lying widely displaced and slightly to the outer side of the medial ridge of the trochlea should lead one to anticipate its occurrence while in the postreduction films the inter-articular position of the fragment is clearly shown (Figs. 9 and 10).

The treatment of the condition necessitates immediate operation to remove or replace the fragment and to free the nerve. The longer the nerve is compressed the greater the time that will be required for its recovery. Occasionally ulnar palsy is absent, but even then the intra-articular fragment should be removed as it will interfere with elbow function. In our opinion it is preferable to excise rather than to replace the fragment as this eliminates the problem of fracture healing and the patient may be treated as for an uncomplicated dislocation alone. If the fragment is removed, it is advisable to transplant the nerve to the front of the elbow for the sake of safety. Excision of the fragment causes no functional impairment.

In our group of 14 patients with fracture of the medial epicondyle associated with dislocation of the elbow, the epicondylar fragment was caught in the joint after the reduction in 5 instances. In 4 of the 5 cases there was complete ulnar palsy. The treatment and results are shown in Table VI.

III. FRACTURES OF THE CONDYLES OF THE HUMERUS

The group of the condylar fractures includes fractures of the medial and lateral condyles and the intercondylar or so-called T fractures. The fractures of the single condyles are usually oblique splits extending downward from the lateral or medial supracondylar ridge respectively into the trochlear or capitellar

TABLE VII.—FRACTURE OF THE CONDYLES OF THE HUMERUS

The group of condylar fractures comprised 50 cases divided as follows:

	House cases	E. W. cases	
Internal condyle	5	11	
External condyle	6	14	
Intercondylar	12	2	
	23	27	
Total			50

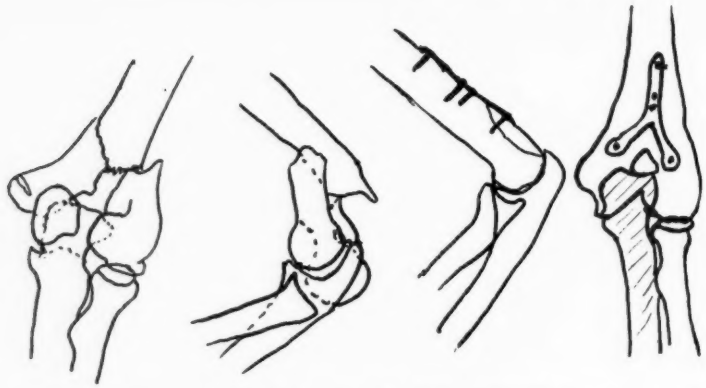

Fig. 11. Intercondylar fracture of lower end of humerus treated by open reduction and internal fixation. A and B. X-rays showing the deformity upon admission to the hospital. C. and D. X-rays taken one year later showing end-result after open reduction.

TABLE VIII.—FRACTURES OF THE CONDYLES OF THE HUMERUS (INTRA-ARTICULAR)

Internal Condyle

Identification	Age	Period after injury	Complications	Displacement	Treatment	Result
H.B. (E.308240)	10	Few hours	None	++++	Closed reduction unsuccessful. Open operation performed with excision of condyle	$A_2 F_2 E_2$ A poor result
H.M. (E.266357)	12	Few hours	None	++++	Closed reduction with fixation at right angle flexion. Second closed reduction performed later with fixation of elbow in acute flexion	$A_4F_3E_4$ Slight limitation of extension
A.P. (O.274878)	34	Few hours	None	++++	Closed reduction unsuccessful. Open reduction performed with fixation of fragment by a steel screw	$A_4F_3E_4$ Slight limitation of extension
C.H.A. (O.278522)	58	Few hours	Recent operation for cataract	+++	Closed reduction performed with fixation of elbow in acute flexion. Mobilization begun at end of 12 days	Immediate result good. No end-result
J.A.M. (E.300704)	68	Few hours	Diabetes. Fractures of patella and carpal scaphoid	++ Previous old fracture of elbow	Reduction not considered necessary. Fixation with sling only. Early massage and mobilization	Immediate result good. End-result not obtained

External Condyle

A.C. (O.258092)	2	Few hours	None	+	No reduction. Fixed in acute flexion	$A_4F_3E_4$
S.M. (O.288835)	20	Few hours	None	+	No reduction. Fixed in acute flexion	$A_4F_4E_4$
P.K. (O.267455)	38	Few hours	None	++	Closed reduction unsuccessful. Open reduction performed, no internal fixation. Elbow fixed in acute flexion	$A_3F_4E_4$
A.S. (O.310337)	37	Few hours	Fracture of toes	++	Closed reduction performed and elbow fixed in acute flexion for 24 days. At the end of 6 months very little motion of elbow. Operation: resection of lateral condyle	$A_3F_3E_2$ Flexion 80° Extension 140°. An industrial compensation case
M.F. (O.269552)	18	Few hours	Posterior dislocation of elbow	+++	Closed reduction performed. Elbow fixed in acute flexion	$A_4F_4E_4$
P.H. (O.271284)	35	Few hours	Wound over olecranon, not compound	+	Débridement of wound. Closed reduction performed with fixation of elbow in acute flexion	Immediate result excellent. End-result not obtained

TABLE IX.—FRACTURES OF THE CONDYLES OF THE HUMERUS (INTRA-ARTICULAR)

Intercondylar (T) Fractures

Identification	Age	Period after injury	Complications	Displacement	Treatment	Result
H.McW. (O.258355)	23	Few hours	Fracture external malleolus	++++	Closed reduction, traction and suspension with elbow in right angle flexion. Poor position	$A_2F_3E_3$ About ¼ limitation of motion
G.McA. (E.279327)	12	Few hours	Primary injury of radial nerve. Later, recovered spontaneously	++++	Closed reduction unsuccessful. Operative reduction with fixation of condyles by screw. About ½ limitation of motion	$A_2F_2E_4$
A.B. (W.265817)	39	Few hours	Old ununited fracture of capitellum	+++	Closed reduction attempted on three different occasions without success. Later, open reduction performed with fair position but resulted in ankylosis. Excision of elbow performed later	$A_0F_2E_3$ Fair motion; but elbow is weak and unstable
E.J. (E.288923)	35	Few hours	Compound and badly soiled	++++	Débridement performed with excision of the condyles. Fixation in traction and suspension with elbow at right angle	$A_0F_3E_4$ Excellent motion but elbow is weaker than normal
T.H. (O.307720)	70	1 year	Ununited fracture	++++	Compound fracture treated by outside physician with failure of union. On account of age, no operation advised. Brace fitted	$A_0F_2E_1$ Patient died 16 mos. later
G.D. (E.310221)	21	Few hours	Old infantile paralysis affecting arm	++	Closed reduction performed and elbow fixed in acute flexion	$A_2F_3E_4$
L.Z. (E.284030)	14	Few hours	Fracture of head of radius	++++	Treated by traction and suspension with elbow in different positions for 3 weeks	$A_2F_1E_4$
L.R. (W.286775)	8	24 hours	Fracture of lower end of radius	++	Closed reduction. Elbow fixed in acute flexion	$A_1F_1E_4$
L.D. (W.276845)	14	Few hours	None	++++	Closed reduction unsuccessful. Open reduction performed with fixation of condyles by screw	$A_2F_3E_4$ Moderate limitation of extension
F.W. (E.268634)	40	Few hours	None	++	Closed reduction. Elbow fixed in acute flexion	$A_1F_3E_4$
E.P. (W.272431)	10	11 days	Scarlet fever	++	Closed reduction performed twice, elbow fixed in acute flexion	$A_2F_1E_4$
P.G. (E.305427)	38	Few hours	Feebleminded. Postoperative infection	++	Open reduction performed 4 days after injury. Fixation with 2 plates and screws. Developed sinus but no osteomyelitis. Healed after removal of plates	$A_1F_2E_4$ Slight limitation of extension

portions of the articular surface of the humerus. The intercondylar fractures are often of the T or Y type—that is, a transverse fracture through the shaft of the humerus at its junction with the condyles combined with a vertical split down between the condyles. These are often accompanied by comminution of greater or lesser extent (Fig. 11).

The condylar fractures are severe injuries and seriously menace the future function of the elbow joint. Extensive pathological changes are produced in the articular surfaces and joint capsule both as a result of the injury and of the reparative process. The displacement on the one hand may be of an extreme type with separation and rotation of the condyles and overriding of the shaft fragment, or on the other, may be almost completely absent. Between these extremes all degrees of displacement may be found. Because of this variation the treatment of condylar fractures is always an individual problem and must be decided after consideration of the nature of the fracture, the extent of the displacement, and the age of the patient.

Our group of condylar fractures comprised 50 cases (11 per cent of the entire group) divided as shown in Table VII. The salient facts about the individual patients are shown in Tables VIII and IX.

It will be noted that a little more than half of the patients (54 per cent) were treated in the Emergency Ward only. All of these were fractures with little or no deformity for whom house admission was not considered necessary. In view of the prevalent impression of the invariable severity of condylar fractures it is a matter of interest to have found among them

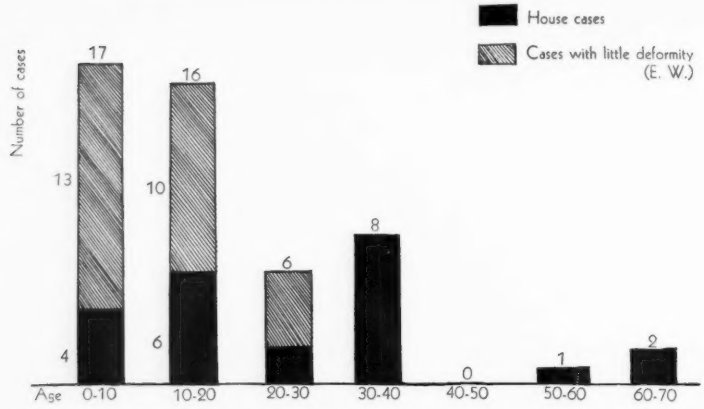

Fig. 12. Fractures of the condyles of the humerus (50 cases). Age distribution by decades.

such a high proportion of injuries that appeared to have but slight functional significance. Such injuries occurred chiefly in the first two decades of life while the fractures with deformity reached their peak in the age group between 30 and 40 years.

End-result examinations were obtained in 20 of the 23 house cases, and the gradings are shown in Table X. From an analysis of these cases the following conclusions seem justified:

1. The method of closed reduction is of value in the condylar fractures with slight or moderate deformity, but is not effective in the comminuted fractures with severe deformity, especially those of the intercondylar type.

2. In condylar fractures with severe deformity the choice would appear to lie between open reduction preferably with internal fixation of the major fragments by screws or plate, or treatment in suspension and traction with early mobilization of the elbow joint. The decision between these methods should take into consideration the patient's age, occupation, and general condition, and the facilities available for performing technically difficult and potentially dangerous operations upon the bones and joints.

3. Following closed reduction of fractures of the medial condyle, retention of position is favored by the position of acute flexion which secures relaxation of the muscles attached to the condylar fragment; for the same reason in fractures of the lateral condyle the position of complete extension is the more favorable.

TABLE X.—END-RESULTS (1 YEAR) AFTER CONDYLAR FRACTURES (INTRA-ARTICULARLY)

Method of Treatment	Results				
	Excellent A_{3-4} F_4 E_4	Good A_{3-4} F_3 E_4	Fair A_2 F_2 E_4	Poor A_{1-2} F_{1-2} E_{2-2}	Unknown
No reduction; fixation only	1	1			
Old ununited fracture; brace fitted				Later excision 1	
Closed reduction and acute flexion	3	3		Later excision 1	2*
Traction and suspension	1		1		
Operative reduction	1	3	1	1	
No reduction, early motion					1*
Excision of condyles (early)			1	1	
Total	6	7	3	4	3

* Immediate results good.

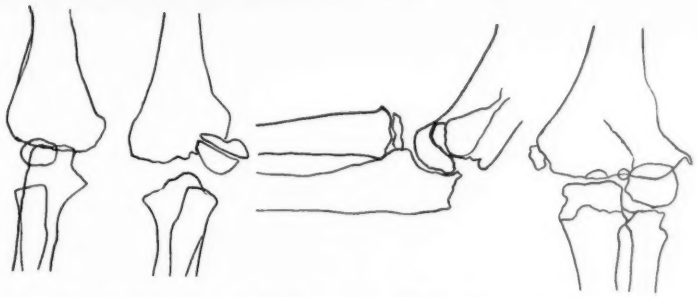

Fig. 13, left. Fracture of capitellar epiphysis with small plaque of bone attached. There is moderate rotary displacement. The normal elbow is shown for comparison.
Fig. 14. Same case as shown in Fig. 13 showing end-result two years after injury. The capitellar epiphysis was replaced by open operation and sutured. There was no arrest of growth.

4. Following open reduction, early mobilization is to be urged, and this is facilitated by secure internal fixation of the fragments. Postoperative support is best provided by the application of traction and suspension apparatus. This protects the elbow and also permits mobilization.

5. Skeletal traction by means of a wire (Kirschner) passed through the olecranon may prove of value in the treatment of comminuted fractures of the condyles with deformity, but was not used in any of these patients. It offers a means of securing continuous extension in the axis of the humerus while at the same time permitting the elbow joint to be maintained in the position of right angle flexion.

6. Excision of the condyles should not be performed, except immediately in certain badly soiled compound fractures as a step in the operation of débridement or late in case of complete ankylosis of the elbow. In the latter condition arthroplasty is preferable to excision, and results in a more stable joint.

IV. FRACTURES OF THE CAPITELLUM

Two types of injury affecting the capitellum must be distinguished: first, those involving the epiphysis, which occur only in children below the age of 15, and second, those involving the capitellar portion of the articular surface in adults. Both are serious injuries, but the epiphyseal fracture is the more common and therefore the more important of the two injuries.

IV A. FRACTURE OF THE CAPITELLAR EPIPHYSIS

Of the epiphyseal fractures one must distinguish between those with incomplete and those with complete displacement.

Incomplete displacement. Many fractures of the capitellar epiphysis are associated with such slight displacement that there is failure to recognize the nature of the injury even upon X-ray examination. The patient is dismissed with a diagnosis of sprain or contusion. Adequate protection of the elbow is not provided, and it is only later when continued irritation has resulted in persistent pain and stiffness that a correct diagnosis is made.

In order to recognize pathological variations it is important to know the normal anatomic features. In the lateral roentgenogram the osseous center of the capitellar epiphysis projects forward and downward from the humeral shaft and gives an appearance somewhat similar to that of a hockey stick with a shortened head. The anterior surface of the epiphysis forms a continuous line with that of the humeral shaft except for the interruption in the shadow due to the cartilaginous plate. In the fractures with incomplete displacement the epiphysis is displaced somewhat posteriorly, and there is a distinct jog in the line of the anterior surface. The roentgenogram must be made with the tube accurately centered so as to produce a true lateral view or this slight displacement will not be recognized. The anteroposterior view fails to show any abnormality, the fracture line being invisible since it coincides with the cartilaginous disk.

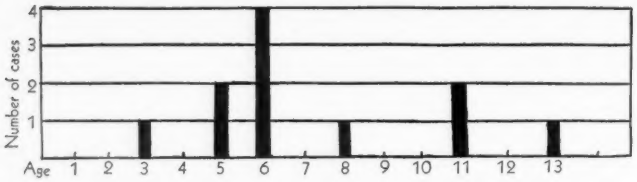

Fig. 15. Capitellar epiphyses fractures (11 cases). Age distribution.

Epiphyseal fracture should be suspected in any child who presents objective signs of injury to the elbow such as pain, swelling, tenderness, and limitation of motion, yet whose roentgenograms at first glance fail to show any evidence of bony injury. The relations of the capitellar epiphysis to the humeral shaft should be scrutinized closely in such cases and a second X-ray examination should be made if any doubt exists as to one of the views being a true lateral one. Films should also be made of the uninjured elbow for purposes of comparison with the normal.

The injury is not of great importance when treated properly. It is unnecessary to correct the displacement, as a rule, as this is too slight to cause any functional disturbance. Exceptions to this rule, however, must be recognized. Fixation of the elbow is, however, necessary, preferably in the position of acute flexion. This should be maintained for a period of 2 to 3 weeks following which mobilization may be begun.

Complete rotary displacement. Fracture of the capitellar epiphysis with complete rotary displacement is a distinct clinical entity which has not heretofore received adequate recognition. The mechanism of the injury is apparently a medial or varus deviation of the forearm from indirect violence, throwing strain upon the lateral ligament of the elbow, which in turn pulls off the capitellar epiphysis, usually with a thin layer of bone attached to the cartilaginous plate. The epiphysis is dislocated outward and rotated upside down by the pull of the extensor muscles attached to its lateral surface (Figs. 13, 14).

There is complete loss of contact between the fractured surfaces and failure of union is bound to result unless replacement is secured. This can be accomplished with certainty only by the open method and in our opinion no other form of treatment should be attempted. Open reduction is easy when performed early; the epiphysis can be fitted back into position and secured by one or two chromic gut sutures passed through the ligamentous attachments and periosteum. Following operation the elbow should be splinted in the position of right angle flexion or partial extension to secure relaxation of the extensor muscles of the fingers and wrist.

Several children with ununited fracture of the capitellar epiphysis have been followed on the fracture service of the Massachusetts General Hospital, and the end-results of the same condition have also been seen in adults. There is increasing deformity of the lower end of the humerus over a period of years due to absence of growth from the capitellar epiphysis. The medial side of the humerus outgrows the lateral side, and there develops marked cubitus valgus deformity. This not infrequently causes elongation or stretching of the ulnar nerve with late or delayed ulnar palsy sometimes not coming on until 15 to 20 years after injury. The loose fragment displaces in and out of the elbow joint on movement, and although a fair range of motion is retained, there is instability and loss of power. In patients with ununited fractures of the capitellum who are seen within 3 to 4 years after injury improvement can be obtained by an operation designed to bring about union between the loose fragment and the shaft with the aid of a bone graft, and the benefits of surgical treatment even at this stage should be more generally recognized.

In our group of elbow fractures there were 11 instances of epiphyseal fracture of the capitellum. The ages of the patients varied from 3 years to 13 years but the peak of the incidence was at the sixth year (Fig. 15). The types of epiphyseal injury that were

TABLE XI.—EPIPHYSEAL FRACTURES OF THE CAPITELLUM

Identification	Age	Age of injury	Displacement	Treatment	Result A	Result F	Result E	Result
Fractures with Slight Displacement								
F.W. (W.294103)	11	6 wks.	+	Fracture healed. Slight deformity. Active use advised	4	3	4	Good
W.B. (E.W.)	5	Fresh	o	No attempt at reduction. Elbow bandaged in acute flexion	4	4	4	Excellent
R.W. (E.293059)	13	24 hrs.	+	Only slight deformity. No reduction. Elbow fixed in acute flexion	3	4	4	Excellent
Complete Fractures with Rotary Displacement								
J.Z. (O.268888)	11	Fresh	++++	Closed reduction attempted but was unsuccessful. Open reduction was performed and good position obtained	3	4	4	Excellent
G.R. (E.291828)	6	7 days	++++	Open reduction was performed with complete replacement. Elbow fixed in acute flexion	4	4	4	Excellent
R.W. (E.301774)	6	5 days	+++	Closed reduction attempted but was unsuccessful. Open reduction was performed with complete replacement. Fixed in acute flexion	End-result not obtained. Immediate result good			
M.D. (O.280259)	3	Fresh	+++	Open reduction was performed with complete replacement. Fixed in acute flexion	End-result not obtained. Immediate result excellent			
L.P. (O.301478)	6	4 years	Non-union of epiphysis	Open operation was performed. Old fractured surfaces were freshened. Bone graft was interposed between fragments to restore normal articular plane. Fragments fixed with 2 steel screws. Elbow fixed by posterior plaster splint in right angle flexion	3	4	4	Good
Complete Epiphyseal Fractures with Lateral Displacement but No Rotation								
J.S. (E.262454)	5	Fresh	++	Closed reductions were performed twice with fixation of the elbow in acute flexion but with little improvement. Patient developed bronchitis, making operative or further attempts at reduction unwise	3	4	4	Excellent
F.L. (O.270550)	8	19 days	Post-lat. dislocation of elbow	Atypical lateral rotation of epiphysis. Open reduction was performed with suture of fragment. Excellent position was obtained	4	4	4	Excellent
B.P. (O.297389)	6	25 days	Fracture already united	Considerable deformity. Epiphysis was displaced outward but not rotated. Open reduction was considered but rejected. Active use was advised	End-result not obtained			

encountered together with the methods of treatment employed, and the end-results so far as they are known, are shown in Table XI. No instances of arrest of growth were encountered and this is due to the fact that the fracture line passes proximal to the epiphyseal plate instead of through it.

IV B. FRACTURES OF THE CAPITELLUM (ADULTS)

Fracture of the capitellum in the adult usually takes the form of a separation of a portion of the articular surface with forward and upward displacement of the loose fragment and the formation of a free body in the joint. Occasionally the fracture is of the compression type, the articular surface being driven upward and impacted into the underlying bone. The fracture is apparently produced by force transmitted upward through the radius, the head being driven against the articular surface of the capitellum. The fracture is frequently associated with other injuries in the region of the elbow such as fracture of the head of the radius or dislocation of the ulna on the humerus. The treatment depends entirely upon consideration of the individual case. When a loose fragment has been separated, it may be necessary to remove this by open operation; in other types of fracture open reduction may be indicated. It is generally impossible to influence the deformity by closed methods.

There were 3 instances of this fracture in our group of 439 elbow injuries, the ages of

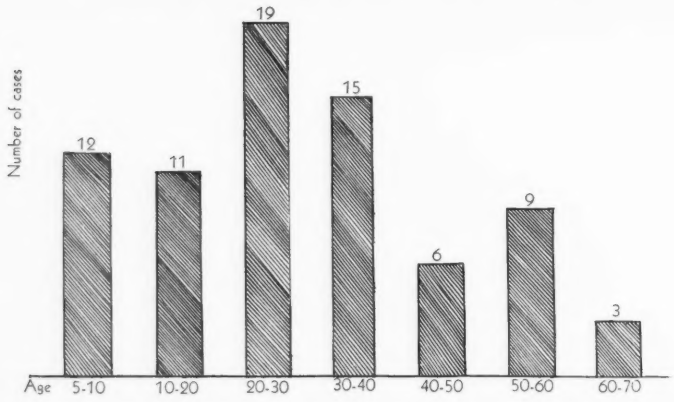

Fig. 16. Upper end of radius fractures (75 cases). Age distribution by decades.

the patients being 42, 51, and 69 years, respectively. In one case the fracture was complicated by posterior dislocation of the elbow; this was reduced and the result at the end of 1 year was graded A_4 F_3 E_2. In the second case there was an accompanying fracture of the olecranon process. This was treated by operative suture with wire. The patient later died of coronary thrombosis. The third patient was only admitted 4 months after injury at which time there was a bony ankylosis of the elbow. Arthroplasty was performed with the insertion of a free flap of fascia lata, and at the end of 1 year the result was graded A_2 F_2 E_3. There was a nearly normal range of motion but some instability and loss of power.

V. FRACTURES OF THE HEAD AND NECK OF THE RADIUS

Fractures of the head and neck of the radius numbered 75 cases, or 17 per cent, of the entire group. After the supracondylar fractures of the humerus and the dislocations of the elbow they constituted the third largest group of elbow injuries. The accompanying graph (Fig. 16) showing the age incidence of the fracture indicates that it is more commonly an injury of adult life than of childhood, and that the peak is reached in the age group between 20 and 40 years.

The injury may be produced either by indirect violence, the force being transmitted along the shaft of the radius and driving the head against the capitellum, or by direct violence acting on the lateral aspect of the upper forearm or elbow. In a fairly high proportion of the cases (27 per cent in our series) the fracture occurs in association with some other injury of the elbow, particularly posteromedial dislocation of the elbow or fracture of the olecranon process. This shows the vulnerability of the head to articular displacements of any kind. The list of complicating injuries is shown in Table XII.

Several different types of fracture of the radial head can be distinguished, and their

TABLE XII.—FRACTURE OF THE HEAD AND NECK OF THE RADIUS

List of Complicating Injuries of the Elbow—75 Patients

Posteromedial dislocation of the elbow (with fracture of coronoid process–5)	8
Fracture olecranon process	10
Fracture upper third of ulna into elbow joint	1
Intercondylar fracture lower end of humerus	1
	20 or 27 per cent

TABLE XIII.—FRACTURES OF THE HEAD AND NECK OF THE RADIUS

Types of Injury and Incidence in 30 Patients

Epiphyseal fractures, upper end of radius	5
Fissure fractures of radial head without displacement	3
Fractures of radial head with displacement	11
Fractures of radial neck with displacement	8
Comminuted fractures involving both head and neck	3
Total	30
Compound fractures	3

differentiation is important from the viewpoint of treatment. The list of these together with their incidence in our group of 30 carefully studied house patients is shown in Table XIII.

The epiphyseal fractures numbered 3, or 10 per cent, in our group of 30 house patients. Two of the patients were aged 8 years and one 13 years. Below the age of 7 years the epiphysis is largely cartilaginous and able to resist injury, and it unites with the shaft at the age of 14 to 15 years so that the age period in which epiphyseal fracture may be produced is relatively short. The osseous center represents only a thin disk of bone and corresponds to the radial head. When the epiphysis is fractured and displaced, it is quite likely to become isolated as a loose body in the joint, devoid of blood supply. This occurred in one of our 3 patients when no operation was performed to replace the epiphysis. In the 2 other patients open reduction was performed and consolidation in good position was obtained (Fig. 17). No method of internal fixation was employed, the fragment being retained in alignment by the position of acute flexion of the elbow. Obliteration of the epiphyseal cartilage occurred in both cases, but no appreciable shortening of the radius resulted since the amount of growth contributed by the upper epiphysis at this age is slight. Table XIV presents summaries of the records of the patients with epiphyseal fracture.

Fractures of the head and neck of the radius, if associated with displacement, commonly cause serious impairment of elbow joint function. Not only does the bony deformity limit or prevent rotation of the upper articular

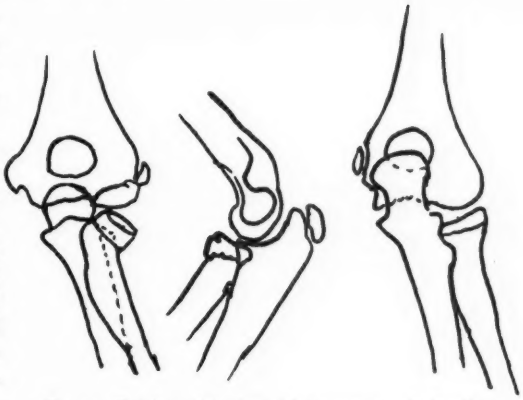

Fig. 17. Epiphyseal fracture of the upper end of radius. A. Roentgen appearance on admission showing tilting of the head. B. Following open reduction. C. Two months later showing union.

element in the lesser sigmoid cavity of the ulna with loss of the ability to pronate and supinate the forearm, but there is frequently limitation of extension of the elbow as well. This is due to scar formation and thickening in the anterior capsular ligament, usually the result of the displacement of a fragment of bone in this direction. To prevent future disability it is necessary to correct the bony deformity, but the situation and nature of the fracture are such as to render it impossible except by open operation. This may take the form of open reduction, excision of the displaced fragments, or resection of the entire radial head. When the bony deformity is absent or slight, no impairment of function should follow, and the only treatment indicated is protective splinting for a period of 2 to 3 weeks with gentle daily mobilization.

TABLE XIV.—EPIPHYSEAL FRACTURES UPPER END OF RADIUS

Identification	Age	Age of injury	Complications	Displacement	Treatment	Result (1 year)			
						A	F	E	
R.E. (W.266360)	13	2 days	Fracture of olecranon without displacement	Marked +++	Open reduction performed 5 days after injury. No internal fixation. Elbow splinted in acute flexion	4	4	4	Epiphysis closed
N.K. (W.276613)	8	6 days	Fracture of olecranon without displacement. Feebleminded	Marked ++++	Elbow fixed in sling at right angle flexion. Reduction not attempted	3	3	3	Supination lacks 15°; extension lacks 20°. Loose body in joint
L.P. (O.276718)	8	14 days	Greenstick fracture of ulna	Marked +++ Callus present	Open reduction performed. Fragment loosened and replaced. Held in apposition by fixation of elbow in position of acute flexion	3	2	4	Only about 20° rotation of forearm. Flexion and extension normal

TABLE XV.—THE RESULTS OBTAINED IN FRACTURE OF THE HEAD AND NECK OF RADIUS

	Total	Good	Fair	Poor	Unknown
No reduction or operation performed	10	3	2	2	3
Open reduction and replacement—Early	5	1		1	3
Late	1		1		
Excision of fragments—Early	4	2	1	1	
Late	1	1			
Excision of head—Early	5	4	1	0	
Late	4	1	1	2	
Total	30	12	6	6	6

In our group of 30 house patients with fracture of the head and neck of the radius, operative treatment was employed in 20. The end-results in these cases are shown in Table XV. In grading these results the term "good" was used to designate 75 per cent or better restoration of pronation and supination and of flexion and extension.

Following the study of these cases and an analysis of the end-results, it seemed fair to draw the following conclusions in respect of treatment:

1. Open reduction ought not to be attempted except in the case of epiphyseal fractures and occasionally in fractures of the radial neck.

2. Excision of loose bone fragments should be performed only in the case of fractures involving the radial head when there is a single fragment and when at least two-thirds of the circumference of the head remains intact, including the inner half that articulates with the ulna.

3. In all comminuted and displaced fractures of the head and neck, resection of the head should be advised.

4. Better results are obtained when resection is performed early (within the first 2 weeks) rather than late.

5. A common complication is ossifying hæmatoma or myositis, particularly in fractures associated with dislocation of the elbow. This may follow resection of the radial head, but is not necessarily the result of operation.

6. To guard against this complication at the time of operation it is necessary to obtain careful hæmostasis and to avoid leaving behind any loose bone fragments. (This is a common error.)

7. Following the excision of a single fragment or the resection of the radial head, the elbow should be splinted in the position of right angle flexion for the period of 1 week, following which mobilization should be begun.

8. Fracture of the head or neck of the radius is a serious injury and while the prognosis is good for the recovery of an useful elbow rarely is it a normal elbow. On the whole the results in this group of injuries were less good than in any other type of fracture or dislocation of the elbow.

VI. FRACTURES OF THE OLECRANON

Fractures of the olecranon constituted the fourth largest group of the injuries of the elbow, and numbered 61 or 14 per cent of the entire group. Of these, 33 were treated in the hospital as in patients, while 28 were treated as out patients. For the most part, these latter represented incomplete fractures or fractures without displacement. They have been used chiefly for statistical purposes. End-result notes (1 year or more after discharge) are available on 25 of the 33 house patients, or in 75 per cent.

The age distribution of the fracture as shown by the accompanying graph (Fig. 18) is fairly even throughout the various decades, but with the peak in the first three.

The injury may be produced by a fall on the outstretched hand, the elbow being in a position of semi-extension, or in rare instances, by direct violence, as from a fall on the flexed elbow or a direct blow. The former is the common mechanism, the olecranon giving way and fracturing as a result of the forcible flexion of the elbow against the resistance of the triceps muscle. In this type of injury the fracture is generally transverse, but there may be one or two small fragments in addition to the main ones. The olecranon fragment is generally retracted and separated from the rest of the ulna by the pull of the triceps, especially when the elbow is flexed. Separation of the fragments depends, however, upon the extent of laceration of the lateral aponeuroses of the triceps tendon which blend with the fascia of

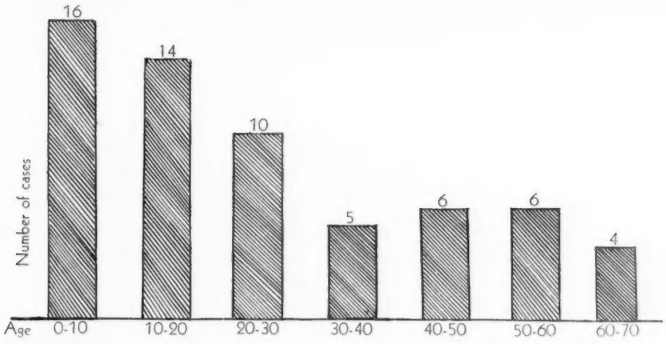

Fig. 18. Olecranon fractures (61 cases). Age distribution by decades.

the forearm and provide a second point of insertion for the triceps muscle. When these are intact, they limit or prevent displacement. Direct violence tends to produce a comminuted type of fracture, and the rarity of this mechanism is shown by the fact that only one example of this was found in 33 fractures. Separation of the fragments sufficient to necessitate operative repair was present in 24 cases; it was slight in 3, and absent in 4.

Complicating bony injuries were present in 14, or 42 per cent of the cases, and of these 9, or 27 per cent, represented other injuries in the region of the elbow. Fractures of the head or neck of the radius were most common and occurred in 6 or 18 per cent of the patients.

The treatment of olecranon fractures depends chiefly upon the amount of displacement that is present. Fractures without separation may be splinted with the elbow in the right angle position for a period of about 3 weeks, but the splints may be removed every day for physical therapy and mobilizing exercises. When the separation is slight, good contact between the fragments can usually be brought about by complete extension of the elbow. The reduction should be verified by X-ray examination, and when the position is shown to be satisfactory, the elbow should be immobilized in this position. Mobilizing exercises should not be started until the end of 3 weeks. When gross separation of the fragments is present, we believe that open reduction and suture is the best method of treatment. It has the advantages of securing close approximation of the fragments, of removing interposing tendinous fibers which interfere with bony consolidation, and of securing bony, instead of fibrous, union. Operative repair, when properly carried out, shortens the period of convalescence and obviates the necessity of prolonged fixation of the elbow. It should be remembered, however, that it exposes the patient to the risk of infection, and that this hazard can be overcome only by skilful surgery and meticulous technique.

We believe that operative repair should bring about such close and firm fixation of the fragments that there should be no need for external splinting, or at the most, for splinting of short duration only. Prolonged postoperative fixation with the elbow in extension always results in slow recovery of function and should be avoided. Kangaroo tendon and chromic catgut are inadequate as suture materials and do not provide the secure fixation of the fragments necessary for early mobilization. We have seen several instances of secondary displacement following operation when these materials have been used. Metallic wire, steel screws, or flanged nails may be used successfully for this purpose, but for a number of years we have been partisan of the use of living fascia lata suture—a method that has been developed and used extensively by the surgeons of the fracture service of the Massachusetts General Hospital for the treatment both of fractures of the olecranon and of the patella. A fascial strip one-half to three-quarters of an inch in width is passed through holes one-quarter of an inch in diameter drilled in both fragments, the ends are tied,

TABLE XVI.—RESULTS OF TREATMENT OF OLECRANON FRACTURES

Thirty-three House Cases

	Total	Excellent	Good	Fair	Poor	Unknown but good at discharge
No. cases treated without operation	10	3	1	1		5
No. cases in which operative repair was done	23	16	1		3	3
Total	33	19	2	1	3	8
Materials used for internal fixation						
Wire	2	2				
Beef bone screw	1	1				
Steel nail	1	1				
Chromic catgut suture	4	3				1
Kangaroo tendon suture	1				1	
Fascial suture (drill holes)	10	8			1	1
Fascial transplant over surface	3	1			ankylosis 1	1
Complicated case of non union	1		1			
Total	23	16	1		3	3
Compound	3	1				2

and the knot made secure by transfixion with interrupted sutures of fine silk. Such fascial sutures live, and do not constitute foreign bodies. On account of their great tensile strength, they secure firm fixation, and the elbow may be flexed to the right angle without danger of separating the fragments. No splinting is required beyond the use of large, soft dressings. Active motion may be begun at the end of 1 week, and the function is quickly regained. A second method of fascial reinforcement that was tried consisted in suturing the fragments with kangaroo tendon and then laying a free flap of fascia lata over the fracture line on the posterior surface and suturing it to the triceps tendon and adjacent soft tissues. This method seemed less good than the other.

The results 1 year or more after injury obtained by the various types of treatment in our group of 33 patients are shown in Table XVI. It is gratifying to note that in 21 of the 25 patients (84 per cent), these were graded as excellent or good. Of the 10 patients treated without operation, 4 had fractures without displacement, and the elbow was fixed only by a sling; in 3 the separation was slight, and the arm was splinted with the elbow in extension; in 2 the elbow was suspended in right angle flexion from an overhead frame. Of the latter 2 patients one had a comminuted fracture without separation, and the other an uninfected, compound fracture without much displacement. One other patient with an accompanying fracture of the head of the radius was admitted to the hospital 4 months after injury. The head of the radius was excised, but the fractured olecranon had healed and did not require treatment.

Open reduction was performed in 23 patients, but 3 operations were required in 1 case so that there was a total of 25 operations. There were 2 postoperative infections, one severe and resulting in ankylosis, the other minor and leading to no functional impairment. The three poor results were caused; first, by postoperative sepsis leading to ankylosis; second, by a complicating fracture of the head of the radius, the functional impairment here probably being accounted for by this rather than by the fracture of the olecranon; and third, by a failure to secure good approximation of the fragments by fascial suture. The latter patient was discharged with what was considered satisfactory although not perfect reduction of his fracture. He drifted into other hands, and 5 months later underwent a second operation on the elbow. When examined at the end of 1 year, it was found that the olecranon had been removed, there was a complete ulnar nerve palsy, and the patient had considerable functional impairment of the elbow. It is fair to question whether this patient would not have had a better result if he had been left alone. One patient with an ununited fracture of the olecranon of 3 months' duration required three operations. At the first the fragments were freshened and sutured with kangaroo tendon, but the postoperative X-rays showed the fragments had re-separated. A second operation was performed 10 days later, and the fragments were fixed with wire. Consolidation was obtained with good function, but 5 months later refracture occurred as a result of a fall. A third

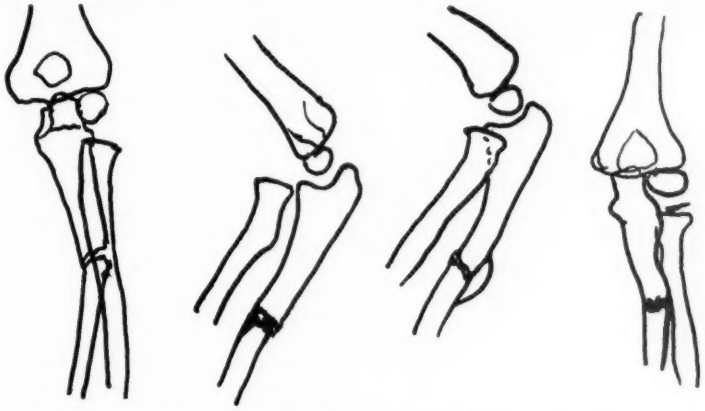

Fig. 19. Anterior dislocation of head of radius associated with fracture of shaft of ulna. A. and B. The deformity at the time of admission. C. and D. Appearance following open reduction of the head of the radius.

operation was performed, and the fragments were sutured with wire and fascia lata. The result at the end of 1 year was graded A_3 F_3 E_3. There were no other instances of refracture. There were 3 compound fractures, and in 2 immediate débridement was performed with suture of the lateral expansions of the triceps. Both of these wounds remained clean, and the reduction of the fracture was satisfactory, but the end-results are unknown. The third patient was admitted 5 days after injury, and the wound, a pin point opening, remained clean.

It may be said in conclusion that:

1. The results of fracture of the olecranon process are in general excellent.

2. The fracture is complicated in about 25 per cent of the cases by other injuries of the elbow, and of these the most frequent are fractures of the head or neck of the radius. Such complicating injuries, when present, modify considerably the prognosis of fracture of the olecranon.

3. Fractures with little or no displacement may be treated with the elbow splinted in extension or supported in a sling at right angle flexion. They may be treated by early massage and mobilization.

4. Fractures with separation should be subjected if possible to operative repair with firm fixation of the fragments by wire, screw, or fascial suture. Internal fixation should be secure enough to obviate the necessity of external splinting and to permit active mobilization at the end of one week.

VII. FRACTURE OF THE CORONOID PROCESS

In the group of 174 house patients with elbow injuries there were 7 instances of fracture of the coronoid process of the ulna. All of the patients were adult, 2 being in the third decade, 1 in the fourth, and 4 in the sixth. Six of the 7 fractures occurred as complications of dislocation of the elbow, and of these 4 were also associated with fracture of the head or neck of the radius, and 2 with fracture of the medial epicondyle. In the seventh patient the fracture of the coronoid complicated a fracture of the olecranon process.

The fracture is apparently caused by posterior displacement of the ulna upon the humeral condyles, the projecting tip of the process being knocked off. The small fragment may be retracted upward by the pull of the brachialis anticus muscle, but in our group of patients the amount of separation was never great. Healing may take place by fibrous instead of bony consolidation, but this of itself ought not to result in any functional impairment. The particular menace of fracture of the coronoid, however, lies in the danger of ossification of the hæmatoma that develops in the region of the fracture and of the anterior capsule. This complication occurred in one of

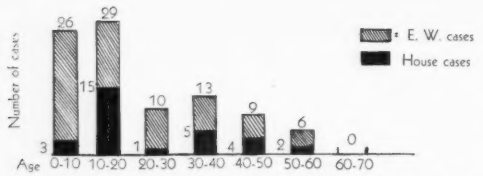

Fig. 20. Dislocations of the elbow (93 cases). Age distribution by decades.

our patients following an operation for an old unreduced dislocation of the elbow. An ossifying hæmatoma developed and resulted in complete bony ankylosis. We are inclined to feel that this resulted from the operation rather than from the accompanying fracture of the coronoid process. In general, fracture of the coronoid rarely needs to be considered from the standpoint of treatment, and all attention may be focused on the treatment of the accompanying dislocation or fractures.

Of the 7 patients 3 were treated by reduction of the dislocation and fixation in acute or right angle flexion; 2 with fractures of the head and neck of the radius underwent operation for excision of the head of the latter bone. In one of these cases the tip of the coronoid was also excised, and this patient obtained a good result. One patient with an accompanying fracture of the olecranon process was treated by operative suture of the ulnar fragments. The results at the end of 1 year were graded as excellent in 3, good in 1, poor in 2, and unknown in 1. Both of the poor results were to be attributed to the accompanying fractures or dislocation rather than to the fracture of the coronoid process.

VIII. DISLOCATION OF THE UPPER END OF THE RADIUS

In the group of 439 elbow injuries there were only 3 instances of isolated dislocation of the radial head, and in all of these the displacement was in the anterior direction. In all 3 patients there was an accompanying fracture of the shaft of the ulna, and in 1 there was a fracture of the olecranon as well. The fracture of the ulna was compound in one instance. The ages of the patients were 8, 17, and 28 years, respectively. The trauma was a blow or fall on the extensor surface of the forearm.

The radial head is retained in its articulating position with the lesser sigmoid cavity of the ulna by the orbicular ligament, and as long as the ulna remains intact the interosseous membrane also constitutes a strong retaining ligament. For these reasons anterior dislocation is almost invariably accompanied by a fracture of the shaft of the ulna, either in the upper or middle thirds. This association is so definite that whenever a displaced fracture of the ulnar shaft is seen without accompanying fracture of the radius, an X-ray examination should be made of the elbow and a dislocation of the upper end of the radius looked for.

Treatment of the dislocation should take into consideration that either the orbicular ligament has been ruptured, in which case operative repair is indicated, or that the head has escaped from under the ligament, in which case replacement can be accomplished only by operative exposure. Furthermore, the relation of the dislocation to the fracture of the ulnar shaft must be borne in mind, and reduction of the ulnar deformity must be accomplished simultaneously with that of the dislocation. Open reduction of the dislocation should be performed through an anterior incision after preliminary exposure and isolation of the radial nerve. After replacement of the dislocated bone, the orbicular ligament should be sutured, and the fracture of the ulna reduced by open operation and plating if neces-

TABLE XVII.—ANTERIOR DISLOCATION OF RADIAL HEAD

Identification	Age	Age of injury	Complications	Treatment	Result
J.H.C. (O.276537)	8	7 days	Fracture of shaft of ulna. Temporary postoperative radial nerve palsy	Open reduction and suture of orbicular ligament	A_4 F_4 E_4 Perfect
E.R. (E.300468)	28	Fresh	Compound comminuted fracture upper third of shaft of ulna into joint	Immediate débridement of compound wound, simultaneous open reduction of head of radius	A_2 F_3 E_4 Incomplete reduction.
J.L. (E.269902)	17	Fresh	Fracture of shaft of ulna, fracture of olecranon	Open reduction of fracture of olecranon with open replacement of radial head	A_4 F_4 E_4

sary. The best position for retention is with the elbow in acute flexion and with the forearm supinated in order to relax the pull of the biceps muscle. Mobilization of the radius in pronation and supination may be started at the end of 7 to 10 days, but the fracture of the ulna requires protection for from 3 to 4 weeks.

It has been claimed that reduction of the radial head is unnecessary for good function, but this is not borne out by our own observations. Instability of the head of the radius results and may be painful, but in any case is associated with weakness that makes heavy work impossible.

The histories of our 3 patients together with the end-results are shown in Table XVII.

IX. DISLOCATION OF BOTH BONES AT THE ELBOW

During the 7 year period under study our records showed 93 patients with dislocations of the elbow. They constituted the largest class of all the elbow injuries, exceeding even the supracondylar fractures, and represented 20 per cent of the entire group. The age distribution is shown in Figure 20. The peak of the incidence is found in the first two decades, and 59 per cent of all the dislocations occurred in this period. There is a marked drop in the incidence in the later decades.

Complicating fractures in the region of the elbow were very common, and were found in 53 patients, or 59 per cent. The list of injuries associated with elbow dislocations in the 30 carefully studied house patients is shown in Table XVIII. From a study of these multiple injuries, it appears that complicating fractures are rare with dislocations in the first decade when the ends of the bones are largely cartilaginous. In the second decade they are common due chiefly to the vulnerability of the epiphysis for the medial epicondyle during this period. They are rare again in the third decade, but after that dislocation is commonly accompanied by a fracture of one of the bony elements—the upper end of the radius, the coronoid process, external condyle, or capitellum.

Dislocation of both bones at the elbow may take place in the posterior, medial, lateral, or anterior directions, that is, the ulna carrying

TABLE XVIII.—TABLE OF FRACTURES COMPLICATING DISLOCATION OF THE ELBOW

Thirty Patients Treated in House

	Cases	Per cent
Fractures of elbow in order of frequency		
Medial epicondyle	13	43
Head or neck of radius	7	23
Coronoid process	5	16
External condyle of humerus	2	6
Capitellum	1	3
Fractures as found in combination with other injuries:		
Fracture of medial epicondyle alone	11	
Fracture of head or neck of radius alone	3	
Fracture of head or neck of radius and of coronoid process	2	
Fracture of head of radius, coronoid process, and medial epicondyle	1	
Fracture of coronoid process alone	1	
Fracture of coronoid process and medial epicondyle	1	
Fracture of head of radius, external condyle of humerus and surgical neck of humerus	1	
Fracture of external condyle of humerus	1	
Fracture of capitellum	1	
Fracture of surgical neck of humerus	1	
Fracture of both bones of the forearm	1	
Epiphyseal fracture lower end of radius	1	

with it the radius may displace from the humerus in any of these directions. We believe it is preferable and more in accord with usage in dislocations elsewhere to describe the dislocation in this manner rather than to observe the traditional method which treats the ulna as the fixed point and designates the type of dislocation according to the direction of the displacement of the humerus. In the group of 30 house patients with dislocations, the displacement was found to be posterolateral in 10, directly posterior in 11, posteromedial in 5, lateral in 3, and undetermined in 1. Thus posterior displacement of one or another type was present in 26 of the 30 patients. There were no instances of anterior dislocation, and this type usually associated with fracture of the olecranon is known to be very rare. In respect to the mechanism of the injury it was impossible to determine the number in which the dislocation was caused by direct violence from a blow or fall on the elbow or in which it resulted from a fall on the outstretched hand. The latter mechanism appeared more common.

From the standpoint of treatment the first and most important requirement is to make an exact diagnosis of the nature of the injury. This ought to be fairly obvious from local examination, but an X-ray examination should

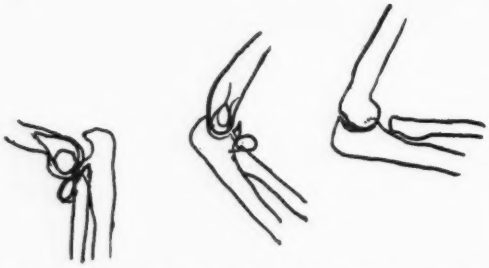

Fig. 21. Posterior dislocation of the elbow associated with fracture of the head of the radius. A. Appearance of deformity at time of admission. B. Following reduction of the dislocation. The radial head is still displaced. C. Following excision of the head of the radius.

always be made to confirm it, and to reveal any accompanying fracture that may be present. In spite of this long established rule there were included in the group 6 patients with late, unreduced dislocations varying from 28 days to 5 months after injury in which a correct diagnosis had never been made.

Dislocation of the elbow, whether or not complicated by fracture, requires immediate reduction. Closed reduction becomes increasingly difficult with the lapse of time, and the earlier it is performed, the easier it is to accomplish, and the less the danger of damaging any of the joint structures. The patient should be anæsthetized in order to obtain complete muscular relaxation and to permit of reduction without the use of excessive force. The elbow should be hyperextended to unlock the coronoid process from the olecranon fossa, and while an assistant exerts gentle traction on the wrist, the operator should apply both thumbs to the olecranon and press the olecranon forward. When the ulna lies in a medial or lateral relation to the humerus it should first be pressed into a directly posterior relationship and then reduced. When reduction is accomplished, the elbow should be flexed to make the reduction secure, and fixed either in acute or right angle flexion depending upon the amount of swelling and circulatory impairment. We commonly make use of a posterior molded plaster splint for this purpose. Post reduction roentgenograms should be made immediately to make sure that complete reduction has been accomplished, and that the relations are normal in both planes.

TABLE XIX.—RESULTS OF TREAMENT OF DISLOCATIONS OF THE ELBOW

	Excellent $A_4 F_4 E_4$	Good $A_4 F_3 E_4$	Fair $A_4 F_2 E_3$	Poor $A_2 F_2 E_2$	Unknown
Fresh dislocations treated by closed reduction	13	5	1[1]		5
Old unreduced dislocations treated by open reduction		2[23]	1[4]	3[567]	

[1]Developed ossifying hæmatoma with large mass of bone lying anterior to head of radius.
[2]Unreduced dislocation 19 days old complicated by fracture of capitellum treated by open reduction.
[3]Unreduced dislocation, 90 days old, complicated by fracture of capitellum treated by open reduction.
[4]Unreduced dislocation, 63 days old, treated by open reduction.
[5]Unreduced dislocation, 56 days old, treated by open reduction.
[6]Unreduced dislocation, 30 days old, incompletely reduced by closed manipulation.
[7]Unreduced dislocation, 56 days old, complicated by fracture of coronoid process, treated by open reduction. Developed ossifying hæmatoma with ankylosis.

In case of fracture of the medial epicondyle one should make sure that the fragment has not become caught in the joint (see "Fracture of Medial Epicondyle") and that there is no evidence of ulnar palsy.

In uncomplicated dislocations the elbow should be immobilized for a period of from 7 to 10 days at which time massage and mobilization may be started, the elbow being supported at right angles by a sling. If there is a complicating fracture it may be necessary to prolong the period of fixation, but it is rarely necessary to make it longer than 2 weeks. Fractures of the radial head or neck with displacement when present as complicating injuries should be subjected to operation with excision of the head of the radius at the end of 6 to 8 days.

The special menace of dislocation is calcifying hæmatoma which usually develops in front of the anterior capsule of the joint. When this process has started, very little can be done to check it, but there can be but little doubt that repeated manipulation of the elbow may be a causative or aggravating factor. Forcible passive movements to increase extension of the elbow are particularly dangerous and should be avoided. Whenever there is slow return of function and the motion is painful and guarded, the possibility of the development of this complication should be borne in mind, and an X-ray examination made. If beginning cloudiness in the soft parts anterior

to the elbow is demonstrated, then the elbow should be put at complete rest. Operative removal of the calcified mass should never be undertaken until after the lapse of 1 year, at which time the ossifying process will have reached a stage of quiescence, and there will be less chance of recurrence. In 3 of our 30 house patients, ossifying hæmatoma developed. It caused restriction of motion and limitation of working ability in 2 and resulted in complete ankylosis in the third. Small areas of calcification in the anterior capsule were noted in 4 other patients, and may have been responsible for slight limitation of extension of the elbow.

Of the 30 house patients 24 were fresh dislocations and were admitted from a few hours to 3 days after injury. Reduction was accomplished in all by the closed method. One patient had a compound dislocation, the lower end of the humerus coming out through a wound on the anterior surface of the arm. Débridement was performed with reduction of the dislocation immediately after admission to the hospital, and the wound healed without infection. There were 6 patients with old unreduced dislocations of the elbow varying in time from 19 to 90 days after injury. Open reduction was performed in all but one. This patient, a boy of 12, was admitted 30 days after injury. Closed reduction was performed, but later was discovered to be incomplete. The result in this case was less good than in any other, and shows the wisdom of resorting immediately to open operation in any elbow dislocation of more than 3 weeks' duration.

The end-results more than 1 year after injury are shown in Table XIX. When it is remembered that 24 out of the 30 house cases were complicated by varying types of fracture, it is gratifying to find such a high proportion of good results. They were classed as excellent or good in 20 patients. The immediate results in the 5 patients listed as unknown were good at the time of leaving the hospital. This accounts for 25 cases or 83 per cent of the entire group. Five of the 6 patients with results listed as poor or fair were only admitted 2 months or more after injury. The results demonstrated that when fresh dislocations of the elbow are recognized and reduced immediately after injury, the prognosis is excellent, and no functional impairment need be expected.

SUMMARY

An attempt has been made to present a bird's eye view of the various injuries designated under the title "Fractures and Dislocations of the Elbow." The different types of injury have been described, the treatment indicated, and attention called to the special dangers that must be avoided in each of the various fractures and dislocations. End-result notes made 1 year or more after discharge from the hospital in 176 of the 439 injuries studied have been presented in order to portray as accurately as possible the outcome that may be expected. We feel justified in concluding that fractures and dislocations of the elbow are not formidable when properly understood and correctly treated. They are a challenge to the surgeon's vigilance and skill, but the victory can be won here as it has been in the other domains of surgery by the use of the weapons already at hand when resourcefully used.

APPENDICITIS

Some Observations Based on a Review of Three Thousand Nine Hundred Thirteen Operative Cases[1]

J. M. T. FINNEY, Jr., M.D., F.A.C.S., Baltimore, Maryland

THIS paper is based on the review of 3,913 cases of appendicitis in which operations were done in one hospital by many different surgeons, during a period of 30 years. The histories of only such patients are considered as showed definite disease of the appendix, gave a fairly definite history of one or more attacks, and were not complicated by other operative procedures at the time of the appendectomy. The cases have arbitrarily been divided into six classes, based on history and operative findings: (1) chronic, those in which the patient had had no definite sharp attack, but rather a grumbling discomfort, and those in which there had been not more than one acute flare-up; (2) chronic recurrent, those in which the patient had had two or more definite attacks and an interval operation had been done more or less prophylactically; (3) sub-acute, in which the operation was performed during or immediately following either a mild attack, or one which was definitely subsiding; (4) acute unruptured, in a large majority of which the appendix showed gangrenous changes; (5) ruptured with abscess, in which there were definite signs of an attempt to wall off the released infection; and (6) ruptured with peritonitis, in which there was a fairly general or spreading infection, with little or no evidence of attempt at localization. (In some instances, particularly the earlier cases in which the histories were rather inadequate or indefinite, it has been rather difficult to be perfectly accurate in this classification, but in general, the cases more or less automatically fall into their proper groups.) It is not so much the purpose of this paper to discuss the literature, which is far too voluminous to be adequately covered in a communication such as this, nor to boast of or excuse mortality statistics—which as a matter of fact conform pretty closely to many others which have been published—as to search for any differences observable during this 30 year period, any changes in the character of the operative cases, or in the results obtained, and to draw such inferences as may seem warranted from the massed material at hand. It would require much more than our allotted time even to touch on all phases, and an endless number of percentages and charts could be offered for consideration, but in this particular study we shall endeavor to limit ourselves to those which have some definite interest or purpose to bring out certain points which seem worthy of special attention or discussion. It is our hope that at some later date we may codify these figures in a more extended and detailed article, if such should seem worth while.

In the cases under review the patients were all operated upon in the old Union Protestant Infirmary, and its present successor the Union Memorial Hospital of Baltimore, Maryland, between the years 1900 and 1930. There are 60 outside surgeons represented, many of them, however, by only 1 or 2 cases, and 39 different house surgeons are responsible for the group listed under resident's cases. So that I think we may fairly say that the results are those which may be expected of the average surgeon, and not of the superman. There are a total of 3,913 cases listed, almost equally divided as to sex, 2,019 males and 1,894 females. The oldest was 90 years, the youngest 13 months. Of these a total of 3,201—1,647 males and 1,554 females—were operated upon by the visiting surgeons, and 712—372 males and 340 females—by the house staff. In the entire group there were 91 deaths—67 male and 24 female—a mortality rate of 2.325 per cent total, or (and this is an interesting point which will be dealt with more in detail later), 3.32 per cent for males and 1.26 per cent females, the former almost three times the latter. Of these 91 deaths, 70 are chargeable to the visiting staff—51 males and 19 females—for

[1]Presented before the Clinical Congress of the American College of Surgeons, October 17–21, 1932.

TABLE I.—GENERAL DISTRIBUTION OF CASES—TYPE, SEX, AND MORTALITY IN FIVE YEAR PERIODS WITH SUMMARIES

5 year period		1900–1905			1906–1910			1911–1915			1916–1920			1921–1925			1926–1930			Totals		
Group	Sex	Cases	Deaths	Mort. Rate	Cases	Deaths	Mort. Rate	Cases	Deaths	Mort. Rate	Cases	Deaths	Mort. Rate	Cases	Deaths	Mort. Rate	Cases	Deaths	Mort. Rate	Cases	Deaths	Mort. Rate
Chronic	F	57	0	0.0	61	0	0.0	65	0	0.0	88	0	0.0	66	0	0.0	113	0	0.0	450	0	0.0
	M	42	0	0.0	33	0	0.0	70	0	0.0	70	0	0.0	77	0	0.0	85	1	1.18	377	1	0.27
Chronic recurrent	F				90	0	0.0	78	0	0.0	83	0	0.0	75	0	0.0	114	0	0.0	440	0	0.0
	M				52	0	0.0	56	0	0.0	55	0	0.0	49	1	2.04	79	0	0.0	291	1	0.34
Subacute	F	29	0	0.0	35	0	0.0	29	0	0.0	57	0	0.0	52	0	0.0	106	0	0.0	308	0	0.0
	M	23	0	0.0	34	0	0.0	44	0	0.0	44	0	0.0	41	0	0.0	54	0	0.0	240	0	0.0
Acute unruptured	F	34	0	0.0	80	0	0.0	58	0	0.0	72	2	2.78	76	1	1.32	143	0	0.0	463	3	0.65
	M	38	2	5.26	65	1	1.54	103	3	2.91	117	3	2.56	119	1	0.84	224	3	1.34	666	13	1.95
Ruptured with abscess	F	28	0	0.0	37	1	2.70	28	1	3.57	23	2	8.69	15	0	0.0	22	1	4.55	153	5	3.27
	M	41	3	7.32	71	6	8.45	69	1	1.45	39	0	0.0	27	2	7.41	38	3	7.89	285	15	5.26
Ruptured with peritonitis	F	11	2	18.18	18	2	11.11	6	1	16.67	11	3	27.27	14	3	21.43	20	5	25.0	80	16	20.0
	M	25	11	44.0	30	10	33.33	16	4	25.0	13	1	7.54	39	5	12.82	37	6	16.22	160	37	23.13
Totals	F	159	2	1.26	321	3	0.93	264	2	0.76	334	7	2.10	298	4	1.34	518	6	1.16	1894	24	1.26
	M	169	16	9.47	285	17	5.96	358	8	2.23	338	4	1.18	352	9	2.56	517	13	2.51	2019	67	3.32

(Grand total 3,913 cases—91 deaths—2.325 per cent mortality rate.)

a mortality rate of 2.19 per cent combined, or 3.10 per cent male and 1.22 per cent female; 21 occurred in house cases—16 male and 5 female— with a mortality rate of 2.95 per cent combined, or 4.30 per cent male and 1.47 per cent female. This slight difference might indicate, on the surface, the advantage of the added years of experience and practise on the side of the visiting surgeon, but actually it may be adequately explained by the greater preponderance of the more serious and advanced cases occurring in the house surgeon's group—relatively there were approximately 20 per cent more ruptured appendices on his list than on the visiting surgeon's. In fact, his mortality rate in handling the latter cases is almost identically that of the surgeon of widest experience and the greatest number of cases on the visiting staff, differing by only .04 per cent. This would certainly seem to indicate that in the hands of a reasonably competent surgeon, there is a certain basic minimum rate, below which we cannot go through surgery alone, but which must be bettered, if at all, by reduction in the number of such cases which come to operation.

This being the situation, what improvement has been made during the past 30 years in getting the acute cases before rupture occurs? In considering this phase, we will eliminate the chronic, and chronic recurrent groups from the figures. This may not be altogether fair, as assuredly the best way to avoid the rupture of an appendix is to remove it before a really acute attack occurs, and frankly, the more we see of the results of ruptured appendices, the more we lean toward the prophylactic removal of that appendage on the slightest provocation—and we believe we can justify that stand, a little later in the course of this paper, by ample figures. But for the present, let us consider what advance has been made in the early diagnosis and surgical treatment of the acute attack. In the 5 years from 1900 to 1905, in the four groups—subacute, acute unruptured, ruptured with abscess, and ruptured with peritonitis—there were a total of 229 cases, of which 105, or 45.85 per cent, had ruptured. From 1906 to 1910 there were 370, with 156, or 42.16 per cent; 1911 to 1915, 353, with 119, or 33.71 per cent; 1916 to 1920, 376 with 86, or 22.87 per cent; 1921 to 1925, 383, with 95, or 24.80 per cent; and 1926 to 1930—in the larger new hospital, 644, with 117, or 18.17 per cent. This, to be sure, shows a

TABLE II.—COMPARISON, HOUSE SURGEONS AND VISITING SURGEONS

	House Surgeon Cases	Deaths	Rate	Visiting Surgeon Cases	Deaths	Rate
Chronic						
Female	63	0	0.0	387	0	0.0
Males	58	0	0.0	319	1	0.31
Recurrent						
Females	64	0	0.0	376	0	0.0
Males	57	0	0.0	234	1	0.43
Subacute						
Females	79	0	0.0	229	0	0.0
Males	42	0	0.0	198	0	0.0
Acute unruptured						
Females	87	1	1.15	376	2	0.53
Males	126	4	3.18	540	9	1.67
Ruptured with abscess						
Females	34	1	2.94	119	4	3.36
Males	49	2	4.08	236	13	5.51
Ruptured with peritonitis						
Females	13	3	23.08	67	13	19.40
Males	40	10	25.0	120	27	22.50
Total females	340	5	1.47	1554	19	1.22
Total males	372	16	4.30	1647	51	3.10

(Representing 39 house surgeons and 60 visiting surgeons.)

TABLE III.—PERCENTAGE OF RUPTURED CASES TO ACTIVE CASES—BY FIVE YEAR PERIODS

	Cases	Ruptured	Per cent
1900 to 1905	229	105	45.85
1906 to 1910	370	156	42.16
1911 to 1915	353	119	33.71
1916 to 1920	376	86	22.87
1921 to 1925	383	95	24.80
1926 to 1930	644	117	18.17
Totals	2355	678	28.79

(Number of cases is obtained by adding all those occurring in the subacute, acute unruptured, ruptured with abscess and ruptured with peritonitis groups.)

definite, gradual, practically uninterrupted improvement, but is it not still a rather sad commentary that in almost 1 of every 5 cases rupture has occurred when the patients reach the operating room? And this in a hospital, where a large majority of the acute cases are patients who come from the city proper or the surrounding suburban area, with an abundant supply of doctors, and good transportation facilities. It does seem that we could reasonably expect considerable improvement in this quarter.

Are there any underlying reasons for this state of affairs which we might remedy? We

TABLE IV.—PERCENTAGE OF CASES RECEIVING CATHARTICS (NOT INCLUDING DEATHS)

	Cases	Cathartics received	Per cent
Subacute	199	61	30.65
Acute unruptured	505	205	40.59
Ruptured with abscess	180	109	60.56
Ruptured with peritonitis	91	56	61.54
Totals	975	431	44.21

(Only those cases used in which there was definite statement in history.)

TABLE V.—PERCENTAGE OF CASES WHICH DIED RECEIVING CATHARTICS

	Cases	Cathartics received	Per cent
Acute unruptured	5	1	20.0
Ruptured with abscess	6	5	83.33
Ruptured with peritonitis	26	19	73.08
Totals	37	25	67.57
Totals Table IV	975	431	44.21
Grand totals, Tables IV and V	1012	456	45.06

(Only those cases used in which there was definite statement in history.)

TABLE VI.—AVERAGE LEUCOCYTE COUNTS IN SIX GROUPS WITH PERCENTAGE OF POLYMORPHONUCLEARS

	Cases	Average count	Per cent polymorphonuclears
Chronic	103	9.017	67.7
Recurrent	79	9.383	67.1
Subacute	399	10.876	73.9
Acute unruptured	785	16.361	84.0
Ruptured with abscess	233	18.696	84.8
Ruptured with peritonitis	144	17.951	87.6

feel that there are several. In the first place, the administration of cathartics in cases of abdominal pain, to which much attention has been directed by various authors. We do not feel that all cases of ruptured appendices are directly traceable to their use, nor do we feel that their exhibition is invariably followed by disaster, but there is abundant reason to believe that they are a potent predisposing factor in many instances, and that the avoidance of their employment cannot be too strongly stressed. In our group of cases, only those were tabulated in whose histories there was a definite statement as to whether or not a cathartic had been administered—nothing was taken for granted— consequently only a relatively small number appears in the table. Also, probably fortunately for the

TABLE VII.—DURATION OF ATTACK BEFORE OPERATION (SURVIVORS)

Group	Sex	Under 6 hours	6–12 hours	12–18 hours	18–24 hours	24–30 hours	30–36 hours	36–48 hours	48–72 hours	72–96 hours	96–120 hours	Over 120 hours	Duration unknown
Subacute	F		1	2	2	7	1	6	25	27	31	170	36
	M		1	1	1	6		4	15	16	23	161	12
Acute	F	7	45	62	49	50	21	47	52	28	15	20	54
	M	17	69	75	64	71	35	77	70	32	27	37	79
Abscess	F			3	3	7	4	8	13	15	14	58	23
	M	2	4	2	9	16	4	20	29	21	25	106	32
Peritonitis	F			1	3	5	1	8	12	11	11	5	7
	M		4	3	4	12	6	16	21	19	11	8	19

individual concerned, a fair number of those who were listed as having received a laxative, had also a notation of having vomited it fairly promptly. In the subacute group, of 199 cases in which a definite statement was made, 61 or 30.65 per cent had had a carthartic; in the acute unruptured group, of 505 cases, 205 or 40.59 per cent; in the ruptured with abscess, of 180 cases, 109 or 60.56 per cent; in the ruptured with peritonitis, of 91 cases, 56 or 61.54 per cent. These all survived operation, but among the fatalities, though the figures are small, the discrepancies are even greater. As there were no deaths in the subacute group, only the last 3 need be considered. Of 16 deaths in the acute unruptured group only 5 are listed, of whom only 1, or 20.0 per cent had cathartics. Of 21 deaths in the abscess group, 6 are listed, of whom 5, or 83.33 per cent had cathartics. And, of the 52 deaths in the peritonitis group, 26—just half—are listed, of whom 19, or 73.08 per cent had cathartics. The campaign to educate the layman, the druggist, and the doctor against the indiscriminate administration of laxatives should be pushed to the utmost. Secondly—and we believe even more important still—the doctor, and by all means the medical student, should be most forcefully warned of and taught, not only the signs and symptoms of the typical case of appendicitis, but also the striking absence of such guideposts exhibited in many instances. This latter point, we feel, is touched on far too lightly, when waiting for them to appear means to the patient much the same thing as waiting for the sentinal glands above the left clavicle to clinch the diagnosis of carcinoma of the stomach. It seems impossible graphically to chart signs and symptoms on an accurate percentage basis in such a way that it would mean anything or be of any great value. Suffice it to say that the cardinal points of constipation, generalized pain shifting to the right lower quadrant, nausea, vomiting, point tenderness, muscle spasm and rigidity, moderate temperature and pulse elevation, high leucocyte count with increased polymorphonuclear differential, and so forth, all these things are present in a few cases, a few of them are present in the majority of cases, and virtually none of them are present in quite an appreciable number of cases. Of them all, the most constant and useful seem to be localized point tenderness and a relative increase in the polymorphonuclear leucocytes—the latter rather than the white blood count taken as a whole. We would take this opportunity to warn against too great dependence upon the white count as an infallible index of the degree of the inflammatory process. Of 1,162 counts recorded in the last 3 groups—acute, abscess, and peritonitis—93, or 8 per cent were under 10,000, and of these 17 were in cases in which the appendix had already ruptured. On the other hand, the average for the counts in the different groups was about as one would expect; in 103 chronic cases, 9,017; 79 chronic recurrent, 9,383; 399 subacute, 10,878; 785 acute unruptured, 16,361; 233 ruptured with abscess, 18,696; and 144 ruptured with peritonitis, 17,951. In every group but one—the acute unruptured—the male counts averaged slightly less than the female. The average percentage of polymorphonuclear leucocytes in the 6 groups were 67.7 per cent, 67.1 per

TABLE VIII.—DURATION OF ATTACK BEFORE OPERATION (DEATHS)

Group	Sex	Under 6 hours	6–12 hours	12–18 hours	18–24 hours	24–30 hours	30–36 hours	36–48 hours	48–72 hours	72–96 hours	96–120 hours	Over 120 hours	Duration unknown
Acute	F	1				1				1			
	M		1		1	3		1	2		1	1	3
Abscess	F							1		1		3	
	M						1	1		1	1	9	2
Peritonitis	F				1		2	2	1	3		4	3
	M			2	1	1	1	6	2	8	2	6	8

cent, 73.9 per cent, 84.0 per cent, 84.8 per cent, and 87.6 per cent, respectively. Thirdly, the all important factor of time. Unfortunately, somebody must once have promulgated the theory that an appendix does not rupture in less than 48 hours from the onset of the attack, and much more unfortunately, he seems still to have numerous disciples. In point of fact, 2 of our series had ruptured in less than 6 hours, 42 at the end of 24 hours, and 164, or 24.2 per cent, by the time the 48 hours were up, and of these 19, or 11.6 per cent, died. Many of the other cases in the "duration unknown" group, or in those operated upon after a greater time had elapsed, would probably fall in this group, were all the facts known, but we are dealing only with known facts, and these figures are amply sufficient to prove our contentions; namely, that ordinarily the time to operate is as soon as the appendix can be reasonably suspected, that the use of an ice-cap to "scatter" the trouble too often does just that, and that the only safe appendix is one in a bottle.

TABLE IX.—MORTALITY RATES IN GROUPS SEPARATELY AND COMBINED

	Cases	Death	Mortality rate
Group A—early or prophylactic operation			
Chronic	827	1	0.12
Recurrent	731	1	0.14
Subacute	548	0	0.00
Total Group A	2106	2	0.095
Group B—operation during acute attack			
Acute unruptured	1129	16	1.42
Ruptured with abscess	438	20	4.57
Ruptured with peritonitis	240	53	22.08
Total Group B	1807	89	4.925

B is more than 50 times A.

It would seem to us much better to remove a half a dozen relatively normal appendices by emergency operations, than to be responsible for the consequences which may attend waiting too long on one.

We fully realize that the statement just made may sound very radical to some, but again we can show that the figures back us up. In the chronic group, out of 827 cases there was 1 death—a mortality rate of 0.12 per cent; in the 731 recurrents, 1 death, or 0.14 per cent; and in 548 subacutes, not a single death. In other words, by prophylactic or early operation, we can offer the patient a mortality rate—2,106 cases with 2 deaths—of 0.095 per cent. Over against this, if the attack proceeds to the acute gangrenous stage, while the chances are still good—1,129 cases with 16 deaths, mortality rate 1.42 per cent—the risk has been increased approximately fifteen times—and the appendix still not ruptured. Next in the abscess group—438 cases with 20 deaths, a mortality rate of 4.57 per cent—the danger increases again by more than three times. And finally in the peritonitis group—240 cases with 53 deaths, a mortality rate of 22.08 per cent—we multiply the chance taken by five, a total increase over the early groups of more than 225 times. Is it worth the risk, when the best the patient can look forward to, if that particular attack does subside under expectant treatment, is the probability of another later one—time, place, and circumstances unknown—plus the ever present chance that the current attack will not subside anyhow? It really seems to us that, paradoxically, the radical stand is the more conservative.

But there is one more argument in favor of our contention—what of the time the patient

TABLE X.—AVERAGE DAYS' HOSPITALIZATION BY GROUPS IN FIVE YEAR PERIODS

Group	Sex	1900–1905	1906–1910	1911–1915	1916–1920	1921–1925	1926–1930	General average	Average combined sexes
Chronic	F	18.9	15.2	17.2	15.1	14.7	14.8	15.9	15.5
	M	17.7	12.5	15.4	15.7	14.7	14.4	15.1	
Recurrent	F		12.4	13.8	13.8	13.9	12.0	13.2	12.7
	M		11.7	13.5	13.3	11.5	11.5	12.3	
Subacute	F	17.4	12.3	14.9	12.9	12.5	11.2	13.5	12.9
	M	16.4	12.6	11.4	11.1	11.1	12.1	12.4	
Acute	F	18.7	14.7	13.3	15.6	13.7	12.2	14.7	14.3
	M	17.6	13.0	13.2	13.9	13.6	12.1	13.9	
Abscess	F	30.0	28.2	32.7	29.7	24.5	31.1	29.4	28.8
	M	31.1	30.5	30.9	25.6	26.4	24.9	28.2	
Peritonitis	F	48.6	36.5	39.8	41.8	36.8	25.7	38.1	34.7
	M	35.1	28.1	38.3	28.4	30.9	26.9	31.3	

may reasonably expect to be laid up in the hospital, and the consequent economic problem to be faced—not to mention the subsequent period of convalescence, which naturally is much longer in the more serious groups of cases, but which cannot be accurately reduced to figures? In the chronic group, the average duration of hospitalization was 15.5 days—this figure results from the higher percentage of exploratory right rectus incisions in this group, the muscle splitting McBurney incision predominating in the others—in the recurrent, 12.7 days; in the subacute, 12.9 days; in the acute unruptured 14.3 days, in the ruptured with abscess, 28.8 days; and in the ruptured with peritonitis, 34.7 days. These figures, being averages, of course cover the entire hospital stay, in many instances greatly lengthened, not only by complications, but also by other subsequent operative or medical procedures in no way related to the appendectomy. (Parenthetically, by the same token the mortality statistics, as given, are not an entirely accurate index, as the deaths include several in no way dependent upon the appendectomy, but occurring during the period of hospitalization, and hence, indirectly, chargeable to it. We hope to remedy these defects at some later date, in a paper analyzing the deaths and complications, but at present, time does not permit it.) In all groups the hospitalization for females averaged somewhat longer than for males. Also in all groups the average time for the last 5 year period—1926 to 1930—is appreciably less than the corresponding average for the full 30 year period, an indication, at least, of better surgical and nursing care, as well as fewer and less prolonged complications. But the difference between the unruptured and the ruptured groups remains just as striking.

We will not attempt to summarize these somewhat rambling and at times, we fear, inco-ordinated remarks, further than to stress once again one fact, which strikes home most forcibly, and which we feel should be given especial emphasis, namely, that even in this enlightened and progressive age, when public attention is being constantly directed toward various health facts or fancies, almost 20 per cent of inflamed appendices have already ruptured when they reach the surgeon.

THE HOPEFUL PROGNOSIS IN CASES OF CARCINOMA OF THE COLON[1]

FRED W. RANKIN, M.D., F.A.C.S., ROCHESTER, MINNESOTA
Division of Surgery, The Mayo Clinic
PAUL F. OLSON, M.D., ROCHESTER, MINNESOTA
Fellow in Surgery, The Mayo Foundation

THE assertion is frequently made that carcinoma of the colon is attended by favorable prognosis if the growth is radically extirpated before visceral metastasis has developed. Such has been our observation and experience. A study of 453 cases in which operation was performed at The Mayo Clinic between 1907 and 1927 was undertaken to evaluate the factors entering into the prognosis.

Influences which modify the outlook following surgical treatment of carcinoma of the colon group themselves into extrinsic and intrinsic elements; the former represent general conditions of the host and certain conditions local to the neoplasm, whereas the latter represent the intensity of the malignant cells.

I. Extrinsic influences:
   1. General:
      - Age of patient
      - Loss of weight
      - Anæmia
      - General debility
      - Cardiovascular and renal impairment
      - Co-existing chronic debilitating diseases, such as diabetes and tuberculosis
      - Duration of growth
      - Direction of growth
      - Glandular metastasis
      - Lymphocytic infiltration
      - Fibrosis
      - Hyalinization
   2. Local
      - Size
      - Fixation
      - Perforation: with or without abscess or formation of fistula

II. Intrinsic influences:
   1. Activity of the neoplastic cells, especially their ability to differentiate or approach the normal state

Consideration of these two types of influence, extrinsic and intrinsic, has led us to the firm conviction that the intrinsic malignancy of the carcinomatous cell affects in direct ratio all of the other factors which modify it. We do not feel that clinical scientific observations and general conditions which influence the prognosis should be excluded from grave consideration, but we feel that it is incontrovertible that the activity of the neoplastic cell is the primary factor which decides between longevity and early recurrence. Unquestionably, such factors as involvement of lymph nodes and distant or hepatic metastasis affect the length of life after operation in direct proportion to their presence or absence. We show later in this paper that involvement of nodes is directly dependent on, and that its extent is proportional to, the grade of the malignancy. Such local conditions as fixation of the growth, perforation, penetration and formation of abscess affect the operability of the growth, but they are merely local influencing factors, which are usually the result either of intense activity of the carcinomatous cell or of prolonged neglect in the absence of symptoms.

The situation of the carcinoma unquestionably is an important factor. Carcinoma of the right half of the colon, for a reason which we are not able to explain satisfactorily to ourselves, is of better prognosis than of carcinoma of the left half. In cases of carcinoma of certain segments of the right part of the colon, for example the cæcum, there is a higher percentage of 5-year cures, or of freedom from recurrence, than when other segments are involved. Such general conditions as anæmia, cardiorenal insufficiency, co-existing debilitating diseases, and loss of weight, obviously are only modifying factors and influence the prognosis by their effect on the condition of the patient.

Age is a very important factor in prognosis. It is a well known fact, proved frequently by many observers, that a youthful host to a malignant growth is at a decided disadvantage compared to a person past middle age. This, we believe, is explained by the activity of the

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tissue cells themselves. The elasticity of youthful tissue, in contradistinction to that of senescence, is less hostile to carcinoma and more readily succumbs to its invasion.

The size of the growth, as has frequently been shown by many observers, and our experience corroborates them, has little if anything to do with the outlook. The size and pathological type differ distinctly in the two halves of the large bowel, and there is no evidence for the conclusion that, in the main, large growths entail a poorer prognosis than small growths. As a matter of fact, it is not uncommon for a surgeon, on extirpating a huge growth which he has considered to be on the borderline of operability, to find absence of metastasis to nodes and a low grade of malignancy, the tumefaction being largely the result of inflammatory reaction. Such types of growth often give the most satisfactory prognosis, particularly if they are situated in the right half of the colon. On the other hand, it is not an uncommon experience to explore a small rectal or sigmoidal growth which is perfectly operable locally, and at the same time to find multiple hepatic metastasis, contra-indicating resection of the growth, except occasionally as a palliative measure.

The factor of direction of growth unquestionably has some bearing on the outcome. It is shown that growths which protrude into the lumen of the bowel give better prognosis by a considerable percentage in a large series than growths which extend toward the serosa. Because these intraluminary growths progress away from the nodes that are in immediate juxtaposition to the bowel and because they are usually of the papillary or adenoid type, and therefore of lower grade of malignancy, they influence the prognosis favorably. On the other hand, the smaller, sessile growths, which extend toward the serosa, frequently are of higher grade of malignancy and metastasize by way of the lymphatic system at an earlier date.

Concerning intrinsic factors, the differentiation or lack of differentiation of the carcinoma cells is, we believe, the most important single influence on prognosis, reacting as it does, either directly or indirectly, on all of the other modifying conditions. The varied microscopic appearance of malignant cells occurring in the same situation has long been thought to have prognostic significance, and conjectures as to the degree of malignancy were based on such observations as the relative number of mitotic figures, the staining reaction of the malignant cells, and their invasiveness. Among other factors, similarly, differentiation was suggested, but it remained for Broders to call attention to the real prognostic significance of differentiation, to prove his contention by large series of cases both of squamous cell epithelioma and of adenocarcinoma, and to provide a system for the grading of malignancy which we believe is the most important single factor in prognosis, affecting, as it does, directly or indirectly, all extrinsic factors.

Rankin and Broders, in 1928, demonstrated that definite correlation exists between the degree of malignancy, as judged by Broders' system of grading, and the ultimate results to be obtained from surgical excision of carcinoma of the rectum. In making a similar study of lesions in the colon, we have followed the rules laid down by him in 1920, in his article on the grading of carcinoma of the lip (modified in 1925), in which he evaluated the degree of malignancy in terms of grades 1 to 4.

PATHOLOGICAL OBSERVATIONS

In order to study to the best advantage the influences on prognosis of the pathological variations, all other variable factors are to be eliminated as largely as possible. The time that has elapsed between the appearance of the tumor and the date of its removal is, of course, a very important variant in the matter of prognosis. An attempt to control this factor is made by a rigid selection of cases; only those cases being considered in which the malignant growth was resectable, in which there was no demonstrable hepatic metastasis and in which, therefore, closure was made at the end of the operation, with a hopeful prognosis. For the same reason cases in which death occurred immediately after operation are also excluded.

From the statistical standpoint, only those cases were considered in which patients were known to have died of recurrence or to have

TABLE I.—SIZE OF CARCINOMATA OF PATIENTS FREE FROM RECURRENCE AFTER FIVE YEARS AS COMPARED WITH PATIENTS WHO SUBSEQUENTLY HAD RECURRENCE

	Cæcum	Right	Left	Sigmoid
Dead (cases)	37	44	46	93
Size (average)	7.7 cm.	7.1 cm.	6.2 cm.	5 cm.
Cures (cases)	47	59	54	73
Size (average)	7 cm.	7.2 cm.	5.7 cm.	5.4 cm.

TABLE II.—RELATIVE PERCENTAGE OF CURES IN RELATION TO SITUATION OF LESION

	Total	Dead	5-year cures	Per cent cured
Right half of colon including cæcum	187	81	106	57.6
Left half of colon including sigmoid	266	139	127	47.7
Total	453	220	233	51.3

been living more than 5 years free from recurrence. In each case of recurrence the exact number of months of postoperative life was known. Thus, the series ranges from patients who died in the second month after operation to patients who were living 24 years after operation. Selected according to the standards before mentioned, there were 453 cases available for study.

The surgical-pathological specimens were studied from five aspects: (1) size; (2) direction of growth, that is, whether the tumor was projecting into the lumen or invading the serosa; (3) involvement of lymph nodes; (4) grade of malignancy as determined by degree of cellular differentiation; and (5) a comparison of mucoid carcinomata with the more solid forms.

Carcinomata of the rectum and rectosigmoid were not included in this study. Due to the physiological and anatomical differences between the right and the left halves of the colon, the series had been divided in accordance with whether the right or left half of the colon was involved; the point of division was the middle of the transverse colon.

The greatest diameter of the growth was considered as the best index in evaluating the effect of size on the prognosis. In Table I is given the average size of the carcinomata of patients who subsequently had recurrences, as compared with the average size of carcinomata of those who obtained cure for 5 or more years. The group labeled right includes the ascending colon, the hepatic flexure, and the right half of the transverse colon. The group labeled left includes the left half of the transverse colon, the splenic flexure, and the descending colon.

From Table I it is seen that in no group did the patients with poor results have appreciably larger carcinomata than did those who obtained good results. When the four groups are averaged together, it is found that the patients who died of recurrence had tumors which averaged less than 0.2 centimeter greater (measured by the longest diameter) than those of patients who lived more than 5 years. The inference is that size has little to do with the prognosis of resectable carcinomata of the colon.

It is interesting to observe that the growths in the right half of the colon were larger than those in the left half, and that those of the cæcum were of largest average size, whereas those of the sigmoid were smallest. As will be observed in Table II, however, the lesions of the sigmoid and left half of the colon not only do not give a better prognosis, but actually give a somewhat poorer prognosis than do the tumors of the right portion of the colon and cæcum.

It has been noted that those malignant growths which project into the lumen give a better result than do those of which the dominant direction of growth is toward the serosa. A lesion which projects itself into the fæcal stream will give rise to symptoms of obstruction or of bleeding earlier, whereas a lesion which invades the serosa will more quickly reach the lymphatic structures and will be disseminated sooner. As FitzGibbon and Rankin have demonstrated, colonic carcinomata not infrequently arise on the basis of polyps, and we found that it is the polypoid carcinomata which assume considerable proportions (while projecting into the lumen) without serosal involvement taking place. From the prognostic standpoint, it is of interest to observe that of the 24 cases which FitzGibbon and Rankin reported of carcinomata which demonstrably had their origin in polyps, 22 were of the lower grades of malignancy.

TABLE III.—DOMINANT DIRECTION OF GROWTH

	Toward lumen	Toward serosa
Average postoperative life of patients with recurrence, months	22.5	21.9
Percentage of 5-year cures	62	41

TABLE IV.—NODAL INVOLVEMENT

Right half of colon, including cæcum (187 cases)

	With nodal involvement	Without nodal involvement
Incidence	34 per cent	
Average postoperative life of patients with recurrence, months	15.7	25.6
Percentage of 5-year cures	39	66

Left half of colon, including sigmoid (266 cases)

Incidence	31 per cent	
Average postoperative life of patients with recurrence, months	18.5	26.5
Percentage of 5-year cures	29	56

In Table III may be seen the results of our study on the direction of growth, and it is apparent that carcinomata projecting into the lumen of the colon give a considerably higher proportion of successful results than do those with invasion of the serosa.

When dissemination of a malignant growth through the lymphatic channels begins, the first sign of the invasion is usually to be found in the local lymph nodes. When only these first outposts are involved, complete surgical removal is still possible, but their involvement makes the surgeon fearful that the malignancy has already become disseminated further, and that undemonstrable distant metastasis has occurred. In Table IV are presented the results of our prognostic studies in relation to involvement of lymph nodes in colonic lesions.

In a recent study on the prognosis of carcinomata of the rectum, Dukes divided the gross specimens into three groups: those with involvement of lymph nodes, those without involvement of lymph nodes but with extension into the serosa, and those without either involvement of lymph nodes or invasion of serosa. He found the prognosis to be best in those cases in which there was not extension and nodes were not involved, next best in the cases in which there was only serosal extension, and worst in those in which the nodes were involved. In our cases of carcinoma of the colon the relationship of extension to prognosis was the same, but we found nodal involvement to be much the most significant factor.

TABLE V.—GRADING OF MALIGNANCY IN RELATION TO POSTOPERATIVE LENGTH OF LIFE

Grade	1	2	3	4
Right half of colon (187 cases)				
Incidence, per cent	16	53	21	10
Average postoperative life of patients with recurrence, months	25.8	22.8	17.4	14.8
Percentage of 5-year cures	68	60	48	37
Left half of colon (266 cases)				
Incidence, per cent	13	67	16	4
Average postoperative life of patients with recurrence, months	33.7	26.5	16.2	14.6
Percentage of 5-year cures	63	51	30	18

TABLE VI.—GRADE OF MALIGNANCY IN RELATION TO INVOLVEMENT OF LYMPH NODES

Grade	1	2	3	4
With nodal involvement (147 specimens)				
Incidence, per cent	11	55	23	11
Average postoperative life of patients with recurrence, months	24.6	19	14.1	14
Percentage of 5-year cures	47	41	15	25
Without nodal involvement (306 specimens)				
Incidence, per cent	16	63	16	5
Average postoperative life of patients with recurrence, months	34.4	27.7	19.6	15.6
Percentage of 5-year cures	72	60	54	36

It is apparent from Table V how close the correlation is between the grade of malignancy and the prognosis, not only as concerns ultimate cure but also in the rapidity with which recurrences are fatal.

Pathologically, carcinomata of the colon and of the rectum have much in common. It is interesting to observe that more than half of the malignant growths of the colon were of grade 2, and that a similar incidence was demonstrated, relative to the rectum, by Rankin and Broders.

Having concluded the study of the various individual factors in prognosis, it is tempting to correlate each factor with the others, individually and collectively. The possibilities are, however, too numerous and the results would be more confusing than clarifying. One such correlation was, nevertheless, indulged in; namely the relationship between grading and involvement of lymph nodes.

TABLE VII.—POSTOPERATIVE LIFE IN 44 CASES OF MUCOID CARCINOMA COMPARED WITH 409 CASES OF NON-MUCOID CARCINOMA

	Mucoid	Non-mucoid
Incidence, per cent	10	....
Average postoperative life of patients with recurrence, months	17.6	22.8
Percentage of 5-year cures	48	52

It is noted in Table VI that grades 1 and 2 were relatively more frequent among the specimens obtained from patients who had no nodal involvement, whereas grades 3 and 4, on the contrary, were relatively more common among the specimens from patients with involved nodes. In view of this observation, it is enlightening to compare the percentages of nodal involvement within the individual grades. In grade 1, 28 per cent of the specimens were from patients with involved nodes; in grade 2, 30 per cent; in grade 3, 36 per cent, and in grade 4, 53 per cent. This progressive increase in the incidence of involvement of lymph nodes, as one passes to the higher grades of malignancy, discloses a definite correlation between the microscopic grade of malignancy and involvement of the regional nodes.

Further study of Table VI, however, disclosed that the grade exerts as much influence on prognosis in the group in which nodes were not involved as it does in the group in which they were involved, and that nodal involvement operates prognostically quite as well in any one grade as it does in any other.

In perusing the literature one will observe that there is considerable difference of opinion as to the malignancy of mucoid carcinomata. Many regard the excess of mucinous substance as a degenerative phenomenon. Parham referred to it as an "uncontrolled function of secretion," and expressed the belief that "mucous formation is a sign of functional differentiation of the carcinoma cells." Opposed to that view, however, is the observation of Rankin and Chumley, that the mucoid carcinomata which are most undifferentiated structurally, secrete the most mucinous material. In view of the variation in opinions, it becomes a matter of interest to study the mucoid carcinomata from the prognostic standpoint.

In the series of 453 cases of carcinoma there are 44 of the mucoid type; these are compared with the 409 cases in which there was no excessive mucinous secretion (Table VII). It is evident that in our series the prognostic difference between mucoid and other carcinomata is not great, but that the mucoid carcinomata are inclined to give a somewhat poorer prognosis.

In concluding the statistical part of this paper, we call attention to the fact that although the factors noted in the tables operate definitely to influence the prognosis in the average of a series, no such uniformity is seen when one individual case is compared with others. What is prognostic for the group is the dominant tendency in the individual case.

PRINCIPLES OF OPERATION AND OPERABILITY

Considering the advanced stage of the disease at which so many, perhaps the majority, of patients with lesions in the colon present themselves for examination and treatment, one must consider as fundamentals of surgical extirpation, attention to obstruction, and rehabilitation. Decompression of the colon then becomes the primary object of all treatment preliminary to resection. It is incontrovertible that obstruction in one of its forms is present in more than three-fourths of the cases of growths of the left and middle portions of the colon. The debilitation, anæmia, and cachexia following growths in the right half of the colon are secondary physiological disturbances. It is not necessary that obstruction is present in such a form as to cause hypertrophy and dilatation of the bowel proximal to the growth, but simply dilatation to a small degree should be looked on as being evidence of a certain amount of obstruction. It is well known that obstruction and ulceration enormously increase the permeability of the colonic wall. Given a foul, ulcerating growth, bathed in a bacteria-laden fæcal current, there is always present a large amount of infection. When factors favorable to increasing permeability are present, the pericolonic tissues immediately adjacent to the growth are especially tender, and the spread of organisms by the examining hand most frequently accounts for ensuing peritonitis.

Local conditions in the bowel, secondary to obstruction, become unfavorable for primary

resection and anastomosis, particularly if they are in the left half of the colon. The wall of the bowel is thickened and œdematous, and the blood supply is encroached on. The blood supply of the colon, however, is much more constant than usually has been believed. Steward's work in this connection is most enlightening and instructive. Failure of resections of the last half of the colon, in the face of slight obstruction, perhaps is due, in the majority of instances, more to infection in the wall of the colon than to failure of the blood supply *per se*, although unquestionably both conditions must be given consideration. In most cases of carcinoma of the colon which occur in middle age or late years of life, obstruction is followed by a sequence of events which rapidly produces dehydration and undermines vital processes. When one remembers that the patients do not appear for examination until 10 to 12 months have elapsed, the fact is appreciated that the malignant offensive has had ample opportunity to effect attrition of nature's mechanism.

Decompression of the colon is accomplished, either by medical measures which are favorably instituted against chronic obstruction, or even against subacute obstruction, but which obviously must be supplemented by surgical drainage in the cases of increasing or acute obstruction. We have found it possible, by medical measures, to relieve practically all chronic obstruction to such a degree that the patients were in favorable condition for operation, but local conditions modify this factor and occasionally it may not be possible to effect decompression in subacute obstruction, except surgically. Surgical decompression in the presence of acute obstruction due to carcinoma is best accomplished by blind cæcostomy. Following the suggestions in the paper of Burgess, published some years ago, we have been much impressed by the favorable employment of cæcostomy without exploration when the malignancy produces an acute obstruction without premonitory symptoms. If a cæcostomy is done by the Hendon method with a bell catheter, "Witzelizing" the bowel in its introduction, the surgeon may subsequently, after the patient has recovered, investigate the bowel, localize the growth, and at the second stage explore the abdomen and institute whatever measures of extirpation seem indicated.

Rehabilitation is a second important fundamental in dealing with carcinomata of the colon. Emergency operations are rarely demanded in such cases. The few in which emergency operation is essential need only decompression because of acute obstruction. Consequently, these lesions may be considered chronic ailments, which permit of more leisurely examination and selection of the optimal time for operation. By overcoming the dehydration and desiccation by blood transfusion and adequate intake of fluid, as well as by a nourishing dietary regimen, one feels that operation is undertaken with less risk.

A third feature of the program of rehabilitation after operation has been the institution, as a routine, of intraperitoneal vaccination in an attempt to elevate resistance and overcome infection. We have now used this in more than 600 cases and feel that it is a distinctly advantageous procedure. Although it unquestionably is of small value when utilized alone, and when other fundamental principles of selection for operation are disregarded, yet in a sequence of events preliminary to operation, we believe it has a distinctly important position.

A fourth feature of the attack on carcinoma of the colon has been, in our experience, an advantageous one; namely, institution of graded procedures for their removal. Obviously, it is not necessary in all cases to employ an operation in two or three stages to remove these growths. Certainly, the more sturdy patients, with small growths which have been discovered early, occasionally may be submitted to resection in one stage with favorable mortality. This is the exception rather than the rule, however, and we are firmly convinced that a wider range of operability, as well as a more radical type of operation, may be accomplished by undertaking removal in multiple stages.

The right and left halves of the colon, differing as they do physiologically and anatomically, are different problems technically when it comes to a question of resection. We believe that the right half of the colon is best removed by an operation in two stages, which consists

of preliminary union of the terminal portion of the ileum and the middle of the transverse colon, and at a second stage removal of the entire right half of the colon, 2 to 4 weeks later. The advantage of end-to-side anastomosis is obvious. The object of resection in two stages is to sidetrack an infected growth and drain the right half of the colon while in addition adequate measures of rehabilitation are being substituted. This is not accomplished by lateral union of the ileum and transverse portion of the colon in nearly so satisfactory a manner. A large portion of the fæcal current continues to pass over the surface of the carcinoma, and the very object of the maneuver in two stages is largely vitiated.

For growths in the left half of the colon, we have come to employ with satisfaction an obstructive type of resection, which is radical removal of the local growth and the node bearing region in immediate juxtaposition to it, leaving a clamp on both ends of the bowel for a period of 48 to 60 hours, and then opening the proximal blade to establish a colonic stoma. The subsequent steps of this operation consist of removal of the diaphragm between the two "gun-barrels" and closure later, if necessary. One of us (8) described this operation in a former publication. At The Mayo Clinic it has been employed continuously since, with increasing satisfaction, in a large group of cases. The mortality rate reported at the time of the original paper has not been maintained; at that time one of us (8) reported 31 cases with 1 death. By extending the scope of the operation and perhaps being a little more enthusiastic than was warranted, the mortality rate has risen to 8.6 per cent, but the conviction is not without its merits that a mortality rate of less than 10 per cent in resections of the left half of the colon is perhaps justifiable if the figures of operability run about 50 per cent. This form of resection is obviously strongly contra-indicated in the face of obstruction, and when we have not been able to decompress the colon satisfactorily prior to exploration, we have abandoned the method in favor of an operation for drainage, such as cæcostomy or colostomy, followed at a second stage by some type of resection. The resection still may be obstructive resection if the surgeon wishes, the objection being that there is the necessity for closing two colonic stomas occasionally, but this is not a serious objection. Also secondary resection may be performed, with anastomosis at the same time.

The old type of Mikulicz operation, popularized years ago and erroneously named, because it was done first by Block many years before, we mention only to deprecate except in a very small and closely selected group of cases. It has the disadvantage of implanting carcinomatous cells in the surface of the wound in about 12 per cent of the cases, and the percentage of cures that follows its application naturally is lower than in more radical types of maneuver. Given a weak, elderly patient, who harbors a carcinoma in a mobile segment of the colon, whose abdominal wall can be rapidly infiltrated by local anæsthesia, and the growth pulled out onto the abdominal wall without exploration, manipulation, or sacrifice of the blood supply, the old type of Mikulicz operation unquestionably is indicated. Further than in this type of case, it has small utility.

OPERABILITY

Operability is so variable in the hands of different surgeons that it is impossible to do more than lay down certain fundamentals, which are subject to modification. Our standards of operability maintain that if there are no demonstrable growths in the liver, or if the growth is not firmly fixed to the parietal peritoneum or adjacent viscera, attempts should be made to remove it unless the general condition of the patient is such that operation offers no chance of success. One might even argue that occasionally growths that are mobile and resectable, and yet have metastasized to the liver, should be extirpated. With this view we have no quarrel, and occasionally carry out resection of the growth as a palliative measure. The reason for this is that death from carcinoma of the liver is relatively painless making justifiable the risk of eliminating an obstructing, ulcerating carcinoma which may attach itself to adjacent viscera. Involvement of lymph nodes, provided the nodes are in immediate juxtaposition to the growth, should not hinder resection. It long has been

recognized that it is impossible to tell, by palpation alone, whether a node is involved, and microscopic section is necessary for this decision. Also, study of this series of cases proves that many patients with growths which were shown at resection to have invaded the nodes have lived long and useful lives without recurrence. Local fixation not infrequently does rule out resection. This is a problem a surgeon must decide on the individual merits of each case. Not infrequently one may remove a uterus to which a sigmoidal carcinoma is attached, or the top of the bladder, or a segment of small bowel, or a segment of the stomach, without operative mortality and occasionally with a brilliant result. In the main, however, such operations are palliative, are undertaken with huge operative risk, and extreme care should be exercised, before they are undertaken, to weigh the advantages and disadvantages to the patient of such a formidable procedure.

Percentages of operability, then, are not very satisfactory gauges from which to draw conclusions. So many factors are concerned that their evaluation is difficult. The highest operability on the colonic and rectal service at the clinic, which we have obtained in recent years, is 68 per cent. Rarely has it ranged below 50 per cent, and somewhere between those figures is probably a satisfactory estimate of operability. If it can be maintained with the present low operative mortality rate, if we can resect as a routine over a span of years one of two carcinomata of the colon and rectum as they appear, with a mortality rate ranging from 5 to 10 per cent, we probably will have struck a higher standard than is the average in the surgical world.

OPERATIVE MORTALITY

Hospital mortality unquestionably has been satisfactorily decreased in dealing with malignant lesions of the colon and rectum within the last decade. Although a high rate of mortality still is recognized as inevitable in dealing with these lesions, certainly, by co-operative care of surgeon and internist, by adequate preliminary decompression and rehabilitation, by introduction of intraperitoneal vaccination and selection of more suitable types of operation for each case, the immediate hospital mortality has been reduced. Unquestionably, the ratio between hospital mortality and operability is an important index in the consideration of end-results following radical surgery. Although every effort should be made to extend the horizon of operability to the utmost, compatible with reasonable hospital mortality, it inevitably follows that such cannot be accomplished without a death rate ranging from 5 to 10 per cent.

It long has been recognized that not only is carcinoma of the right half of the colon more favorable for ultimate cure following resection, but also that operation can be performed with lower hospital mortality than if the growth is in the left half. It is not our purpose to consider the factors which enter into this, but our experience in this respect parallels that of other surgeons.

In the study of this particular series of 453 patients with carcinoma of the colon, we included only those who recovered following resection, and who were dismissed from the hospital. In order to obtain some idea of hospital mortality, we reviewed the operations done on the right and left portions of the colon at The Mayo Clinic by the whole group of surgeons, during 1930 and 1931. In the right portion of the colon, where the choice of operation was ileocolostomy in one or two stages, and resection, there were 84 operations with 9 deaths in hospital, or a mortality rate of 10.7 per cent. In the left half, on the service of one of us (Rankin), from January 1, 1929 to February 1, 1930, one type of operation that was accepted as a standard but which could not, of course, be done in all cases, was obstructive resection; 31 operations were done with 3 deaths in hospital, or a mortality rate of 9.6 per cent. Although this is not consonant with the customary mortality, lower with reference to the left than to the right portion of the colon, an average mortality rate of 10 per cent for the whole colon, we believe, is not unreasonable, provided the operability is not reduced below 50 per cent.

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DIVERTICULOSIS AND DIVERTICULITIS WITH PARTICULAR REFERENCE TO THE DEVELOPMENT OF DIVERTICULA OF THE COLON[1]

VERNON C. DAVID, M.D., CHICAGO

THE appearance of diverticula in the body is widespread. The most commonly observed sites are the upper and middle portions of the œsophagus, the duodenum, the jejunum (Meckel's diverticulum), the colon, and the bladder. The more unusual sites are the larynx, the lower end of the œsophagus, the stomach, the ileum, the ureter, the urethra, and the biliary and pancreatic ducts.

The most satisfactory classification of diverticula is probably that, based on their origin, into the congenital and acquired types; because so called true diverticula containing all the layers of the structure from which they take origin may be either congenital or acquired and may eventually change into so called false diverticula. In the latter instance the herniating mucosa and submucosa is the most conspicuous structure present in the false diverticulum.

The large bowel is probably more frequently the seat of diverticula than is any other structure in the body. While large single congenital diverticular sacs in the colon have been described, by far the most common type is the acquired. These may be present in large numbers and may involve all portions of the colon, rarely the rectum, but most frequently the sigmoid colon. As will be shown later, these diverticula may be microscopic in size and consist only of herniation of the mucous membrane through the circular muscle of the bowel or, as we commonly recognize them, they may be the size of a pea or hickory nut and often contain fæcaliths. These sacculations of the colon were adequately described by Cruveilhier in 1849, by Virchow in 1853, and Rokitansky in 1856. According to Sommering they were also described in Matthew Ballies' *Morbid Anatomy* in 1794.

The incidence of the involvement of the colon in diverticulosis can perhaps be best emphasized by quoting the report of W. J. Mayo, in 1930. In this report 2,139 cases were considered. Five to 7 per cent of all colon examinations revealed diverticula. Spriggs and Maxer report that diverticula of the colon were shown in 8.3 per cent of all the patients subjected to gastro-intestinal X-ray examinations. In the Mayo group it was estimated that 5 per cent of adults over 40 years of age have diverticulosis of the colon, whereas, such a diagnosis was made in only 28 patients under 40 years of age. Hartwell and Cecil have reported 2 patients, 7 and 10 years of age, respectively, and Ashhurst 1 patient, 7 years of age, with diverticula of the colon.

The two outstanding etiological factors seem to be age and constipation. Adiposity has been mentioned as a predisposing factor, but diverticulosis of the colon has been observed in many thin patients.

The factors underlying the development of diverticula of the colon have received much thought. There are several anatomical arrangements in the colon that may predispose to diverticulosis. Poirier and Charpey have pointed out that the three longitudinal muscle bands or tinea of the colon include practically all of the longitudinal muscle of the colon. Between these tinea isolated bits of longitudinal muscle may be found, but in the main the muscularis in these areas is composed of circular muscle alone. The pleated or gathered appearance of the colon is due to the formation of three rows of sacculations between the longitudinal muscle bundles (Fig. 1). These sacculations are separated by falsiform ridges (Fig. 2) composed of all layers of the intestine, as much mucosal as muscular. The circular muscle is reinforced in them and augmented in volume. These sacculations and ridges of the colon retard the passage of fæces and in constipated subjects Charpey observed sacculations of large size, like diverticula, which really were but exaggerations of the normal structures.

[1]Presented before the Clinical Congress of the American College of Surgeons, St. Louis, October 17-21, 1932.

In addition anatomically, the penetration of the muscularis by the blood vessels seems to offer areas of weakness in the bowel wall. Klebs first called attention to the possibility of diverticula developing through the areas of penetration of the muscularis by the vessels, and emphasized traction on the mesentery by a fæces loaded bowel as a factor in increasing the size of the vessel openings. Ernst Graser studied this phase of the subject very carefully, making serial sections of the bowel wall along the mesenteric attachment. He found several microscopic diverticula which were herniations of the mucosa through the circular muscle. He emphasized as an important factor in the development of diverticula passive hyperæmia, which dilated the veins and so increased the space of their penetration through the muscularis of the bowel. He wisely observed, however, that diverticula are not always associated with passive hyperæmia. In adverse comment on the theory of Graser, Sudsuki studied the sigmoid in 28 heart cases all suffering with passive hyperæmia and found diverticula in only 6. He examined 12 other cases of diverticulosis where no passive hyperæmia existed.

Von Hansemann observed at autopsy an old man of 85 years who had over 400 diverticula of the ileum, jejunum, and sigmoid. In the ileum the diverticula were at the mesenteric attachment and at the site of the penetrating vessels. In the sigmoid they were at the antimesenteric border at either side of the tinea where there was little or no relation to penetration of blood vessels.

Considering these points experimentally, Herchl, Hannon, and Goode injected water under pressure into the intestines of corpses and found that rupture of the bowel took place at the mesenteric border. In live dogs, however, the same experiment resulted in rupture at the antimesenteric border. (Clumpsky, Beer.) It will also be remembered that, when a compressed air hose has been applied to the anus in spirit of playfulness and the colon has been suddenly forcefully dilated, rupture of the colon has usually occurred opposite the mesenteric attachment.

Edwin Beer, in a most excellent critical review, points out that, while the venous channels through the muscularis may be factors in the development of diverticula at the mesenteric border, in diverticula of the colon their most frequent site of development is on either side of the tinea opposite the mesenteric border and into the appendices epiploicæ. He believes that muscular deficiency is an important factor. This may be due to wear and tear of age, constipation or muscle degeneration, and that through weakened areas by reason of pressure from within caused by constipation, diverticula develop.

Wolf has recently advanced a new theory that due to a disturbance of the neuromuscular system of the intestine there is a dysfunction of the rhythmical contractions of the segments of the large intestine. Eventually a small piece of mucosa is caught up between muscle bundles and forms the beginning of a hernial protrusion.

We have recently studied histologically a number of sigmoid colons containing small diverticula without inflammation, as well as the colons of aged subjects in whom no clinical suspicion of diverticulosis existed. It is an interesting fact that if one carefully observes the sigmoid colon of old people at autopsy the normal sacculations (*bossulares* of Poirier and Charpey) are markedly developed and from these can often be expressed small round balls of fæcal material. The sections of such bowel taken between the tinea opposite the mesenteric border frequently show microscopic diverticula, which do not follow the vessels through the muscularis and consist of herniations of the mucosa and submucosal muscularis and fibrous tissue through the circular muscle (Figs. 3, 4). These diverticula show no evidence of inflammatory reaction about them and from the outside of the bowel their presence could not be suspected, except in a few instances where small fæcaliths may be seen as dark spots in the subserosal fat. These diverticula are really microscopic in size and as far as can be ascertained cause no symptoms and histologically have no evidence of inflammation about them. We believe that they are of frequent occurrence in the old and are a rather common accompaniment of muscular changes, such as the fatty degeneration which occurs in the bowel wall of old

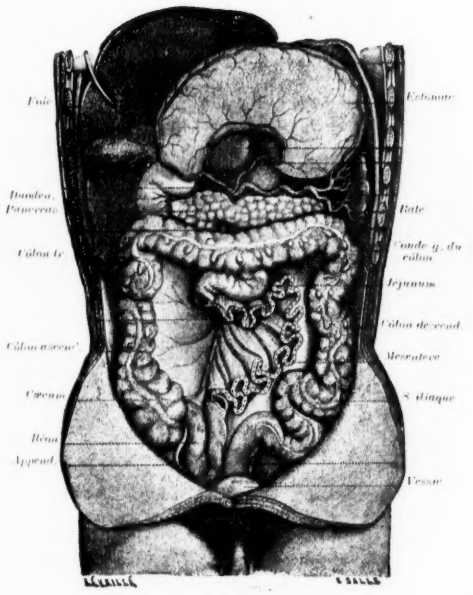

Fig. 1. Drawing showing the sacculated appearance of the large intestine due to ridges composed of circular muscle and mucosa shown in Figure 2. (From Poirier and Charpey.)

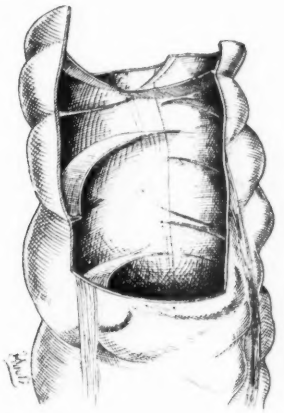

Fig. 2. Falsiform ridges between the longitudinal muscle tinea formed by circular muscle and mucosa which cause the pleated or gathered appearance of the colon. (From Poirier and Charpey.)

people. That these diverticula finally protrude through the entire thickness of the bowel wall and usually into the appendices epiploicæ is well known. Even at this stage where the neck of the sac penetrating the bowel wall is small and the pouch outside the muscular portion of the bowel wall is the size of a pea and contains a fæcalith, evidence of inflammation may be entirely lacking (Fig. 5). Histologically it is seen that the convexity of the diverticulum is covered with mucosa, muscularis mucosa, and the fibrous tissue under the mucosa, but that circular muscle is entirely lacking and that only occasionally a few fibers of the longitudinal muscle is present. It is very easy to see that when inflammation takes place within this sac, it may be the cause of inflammatory processes outside of the bowel wall, such as adhesions, abscess formation, fistula in the neighboring structures, etc. In the histological sections there are areas showing the vessels penetrating the circular muscle of the bowel and creating a real break in the muscularis without any tendency for the mucosa to herniate through the muscle (Fig. 6). Conversely, along the neck of the diverticulum penetrating the circular muscle there is no particular evidence of large blood vessels (Fig. 7).

It appears then that, in the aged, conditions exist in the muscularis which allow an easy herniation of the mucosa and submucosa. This hernia goes between circular bundles and is at first surrounded by them. After completely penetrating the muscularis, the periphery of the sac is covered by mucosa and submucosa consisting of the muscularis, mucosa, and fibrous tissue and over this the subserous fat. As the diverticulum increases in size it commonly insinuates itself into the base of an appendix epiploica where the body of the sac enlarges into a globular structure and commonly contains dry fæcal material or a real fæcal concretion. The neck of the sac is small as it penetrates the muscularis and the opening into the bowel may be very difficult to see. During this whole stage of development no evidence of inflammation may be present in histological study, though it is logical to assume that ideal situations exist for inflammation in the body of the sac, which has a narrow opening into the bowel and may be easily occluded.

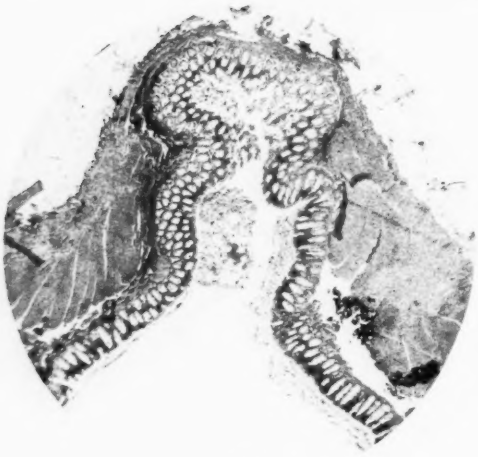

Fig. 3. Microscopic acquired diverticulum of the colon opposite the mesenteric attachment between the longitudinal muscle tinea penetrating the circular muscle. Herniating mucosa covered with muscularis mucosa and some circular muscle fibers. There is shown no evidence of inflammation.

Fig. 4. Small acquired diverticulum of colon completely penetrating bowel wall into appendix epiploica. Circular muscle of bowel shown extending part way up sides of the sac and well developed muscularis mucosa completely covering sac. *a*, Appendix epiploica; *b* circular muscle; *c*, muscularis mucosa.

The pathology, symptoms, and treatment of diverticulitis will be considered under one head, because the symptoms and their treatment depend on the particular pathological process present in any given case.

The literature contains many splendid contributions which will be here but briefly generalized. (Edwin Beer, Hartwell and Cecil, Watson, Mummery, Spriggs, Telling and Gruner, Telling, Judd and Pollock, Case, Rankin and Brown, and W. J. Mayo). Mayo's classification will be followed as it seems to be not only simple but the most inclusive.

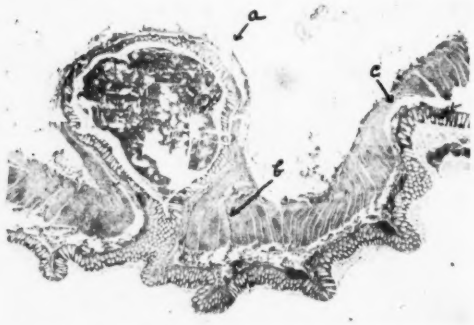

Fig. 5. *a*, Well defined acquired diverticulum of colon herniating through circular muscularis and containing fæcal material. No evidence of inflammation. *b*, Penetration of vessels through circular muscle without any tendency to diverticulum formation. *c*, Beginning microscopic diverticulum.

1. *Self-limited diverticulitis* is the most common type (Figs. 8, 9). The inflammatory process is limited to the wall of the sac and is characterized by recurrent attacks of abdominal soreness, cramps, irregular bowel habits and gas formation. Because of the feeling of incomplete or unsatisfactory bowel movements, the patient takes cathartics or falls into the hands of a "colonic flusher," both of which habits are bad. The treatment consists in the exclusion of seeds, bran, nuts, coarse, undigestible material, and the inclusion of cooked fruit, finely divided cellulose vegetable in the diet. Local application of heat and the tincture of belladonna will relax bowel spasm and control the pain in most instances. The patient should lead a "paraffin" life (DeQuervain) taking mineral oil daily. While cure of this condition is not possible, by following the above regimen the

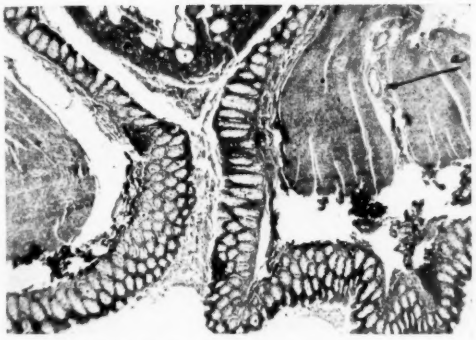

Fig. 6. Neck of diverticular sac penetrating circular muscle of colon but with no evidence of large blood vessels accompanying the sac. At *a* blood vessels penetrating the circular muscle layer without tendency for herniation of the mucosa.

Fig. 7. Well defined acquired diverticulum of colon completely penetrating the circular muscularis. No evidence of large vessels accompanying the herniation of mucosa and submucosa.

patient usually gets along with reasonable comfort. It should be emphasized that cathartics and large enemas are the worst possible agents to employ.

2. *Peridiverticulitis.* A. The process may be acute with sudden onset, leading to perforation with peritonitis. Here the symptoms and treatment are the same as in acute perforative peritonitis except that the process is on the left side.

B. The process may be chronic with recurrent attacks of local peritonitis with adhesions which occasionally involve the bowel in kinks or volvulus. The symptoms in this group are of local peritonitis or of chronic or acute ileus. In the former the treatment is expectant and palliative, and in the latter operative if the process is acute or interferes to a serious degree with intestinal function.

3. *Diverticulitis and peridiverticulitis with abscess formation* may result in entero-intestinal, enterovesical, (Fig. 10) enterocolic, or other fistulæ. Local abscess formation or retroperitoneal abscess formation beneath the sigmoid or cæcum (Fig. 11) may give symptoms similar to perinephritic or appendiceal abscess. In this unusual type of extraperitoneal abscess formation the relation to diverticulitis must be kept in mind in order to make a diagnosis. If the process is subacute and a large mass develops, there may be evidence of ileus and a colostomy above the process will be indicated. In enterovesical fistula this is often desirable and after the acute inflammatory process has receded, the fistulous communication can be disconnected by operation (David). When the process is acute the resemblance to appendiceal abscess or perinephritic abscess makes a differential diagnosis difficult or impossible. Retroperitoneal drainage should be carried out.

Fig. 8. Large acquired diverticula of sigmoid colon.

Fig. 9. Multiple diverticula of colon especially involving sigmoid.

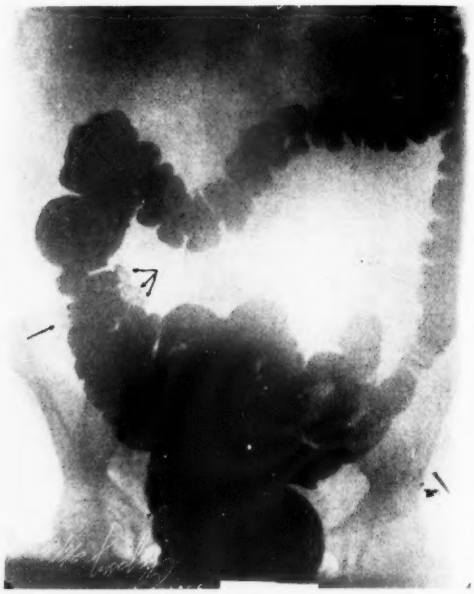

Fig. 11. Large diverticula of ascending colon which had suddenly penetrated the bowel and resulted in a retrocæcal abscess which simulated acute appendicitis under which diagnosis the patient was operated upon.

Fig. 10. Multiple diverticula of colon with filling defect at *a* due to chronic inflammatory narrowing and accompanied by an enterovesical fistula at that point. A subhepatic abscess developed later from a diverticulitis of the hepatic flexure of the colon.

Fig. 12. Filling defect of sigmoid colon due to inflammation and fibrosis of the bowel by reason of multiple diverticulitis.

4. *Diverticulitis associated with obstruction of the bowel*, giving the symptoms of tumor, filling defect in X-ray (Fig. 12), and in 5 to 10 per cent of the cases blood in the stool (Spriggs) makes a differential diagnosis from carcinoma of the bowel very necessary. The pathological process is one of chronic inflammation of the bowel wall around the diverticula, resulting in fibrosis of the bowel wall and narrowing of the lumen of the bowel. The differential diagnosis from carcinoma is not easy and may be impossible to make. The chronicity of the lesion, the presence of other diverticula, and the absence of blood and pus in the stool favor diverticulitis. The correct diagnosis can be made only at operation in some cases and Daniel Jones properly emphasizes the necessity for operative exploration when bleeding from the bowel is from high up and there is a filling defect in the colon. In differentiating diverticulitis with bleeding from carcinoma of the colon, Jones points out that the surgeon will be in error more often if he fails to explore such patients. If the fibrosis of the bowel from diverticulitis reaches the point of obstruction and symptoms of obstruction are present, the bowel should be resected, usually after a preliminary cæcostomy.

5. *Diverticulitis with carcinoma*. If there is a causal connection between diverticulitis and carcinoma it has not been clearly demonstrated. That diverticulosis and diverticulitis are often noted in the presence of carcinoma is well known, and diverticula in close relation to carcinoma is also observed. It is safe to say that the relation of chronic inflammation to carcinoma is much the same in the bowel as it is elsewhere in the body. The important principle is that early exploration is warranted if any suspicion of carcinoma exists.

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HISTORY AND DEVELOPMENT OF THE SURGICAL TREATMENT OF FACIAL PALSY[1]

ARTHUR B. DUEL, M.D., F.A.C.S., NEW YORK

THERE is a trite saying that "the face is the mirror of the soul."

The crude drawings by the earliest artists as well as the finest portraits by the great masters of painting have depicted character, or the state of mind of their subjects, not alone by their positional attitude, but, in addition, by the expression of the face. Ever since there have been written records, descriptions of facial expression have been employed to portray characters or moods. The historian, the poet, the dramatist, the writer of fiction, the story teller, have all leaned quite as heavily on descriptions of facial expressions to depict the vagaries of mind of their characters as they have on the recital of what these persons have said or done.

The constant emotional response in the facial muscles to the vagaries of mind of an individual gradually molds his visage into an almost unmistakable type, certainly evident to a practiced physiognomist, and, usually as well, to his sophisticated fellow-beings.

Volitional changes of expression also are very manifest; yet it is the constant play of emotional expressions rather than the voluntary movements which bring about the facial configuration that characterizes the individual.

My present discourse deals exclusively with the lesion known as facial palsy. I need hardly dwell upon the intense misery experienced by the victim. Inasmuch as he or she is deprived completely of what we may call "the language of facial expression," the whole social life of the sufferer is threatened, and, in many instances, the capacity for self maintenance is seriously impaired, if not entirely lost.

In my examination of the multitudinous case reports, I have noted that the French observers depend largely upon the word "grotesque" to describe the facial appearance of the patient.

Considering the pitiful nature of the results of the lesion it is not surprising to find, in the medical literature dealing with the subject, evidence both of the deepest sympathy on the part of the surgeon or physician, and an eager grasping at any remedy that promises complete, or even partial, recovery.

In a chronological bibliography, beginning in the year 1776, which was prepared for me at the New York Academy of Medicine, I found myself confronted by some 1,829 articles, all dealing with facial palsy. Some of these articles are merely case reports; others deal with the probable cause of the lesion; others with the then accepted remedies.

Up to the year 1879, there is no recorded attempt to "cure" facial palsy by surgical methods. Drobnik at that time anastomosed the spinal accessory to the facial (10).

Occasionally, there is keen vision into the possibilities of surgery based on recoveries which followed spontaneous or surgical cures of suppurative conditions in the middle ear or mastoid bone.

The writings of that great observer, Sir Charles Bell, well over a century ago, will always be a delight and inspiration to all who may be interested in this particular field (3). His classical work published in 1822 on *The Anatomy and Philosophy of Expression* embodies an analysis of emotional and voluntary expression in man and animals based on a very exhaustive anatomical and physiological research. He pointed out the elaborate system of muscles provided for the infinite shades of emotional expression in humans as compared with the simpler outfit provided in the lower animals to meet their requirements.

About the year 1890, keen observers in the treatment of facial palsy had discerned that when the lesion had resulted from suppurating ears, or mastoiditis, recovery from the paralysis often followed the arrest of the purulent discharge, whether this occurred spontaneously, or by operative interference.

When surgery of the temporal bone had so advanced that operators no longer feared t

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Fig. 1. At time of operation, March 18, 1931.

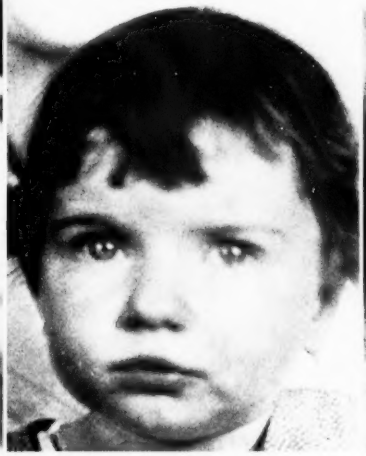

Fig. 2. In repose, 14 months later.

Fig. 3. Showing emotional response, 14 months later.

invade this particular region, the results were twofold: on the one hand there were those who were possessed of an extreme fear lest they should even touch the facial nerve. Facial paralysis must be avoided at all costs! On the other hand, there were those who, fired by overenthusiasm, or overconfidence, were less cautious. Consequently unskilled surgery of the temporal bone brought with it an ever increasing number of cases of accidental facial paralysis.

Confronted by these lamentable facts in the next decade, constructive efforts to repair the palsies resulting from these accidents were made by several men.

As early as 1895, Sir Charles Ballance (1) united the distal end of a divided facial nerve to the side of the spinal accessory nerve. The face responded a few months later to faradic stimulation and there appeared a partial voluntary control of the facial muscles together with marked associated movements of the shoulder. In 1898, Faure (12) united the facial to a branch of the spinal accessory. Then followed in rapid succession experiments by Barrago-Ciarella (5) and Manasse (18). Their efforts were confined to anastomosis of the facial nerve with adjacent nerves in the neck.

Without attempting to give a complete survey of this work, I may mention Ballance, Watson-Williams (22) and Colledge in England, Gluck (14), Kummer (16), Koerte (15), Tilmann (21) in Germany and Austria, Harvey Cushing (9), Frazier and Spiller (13), Keen, Taylor, Elsberg, Beck (6), Adson, Lillie, Learmonth, in America, and Faure in France.

Improvement in technique and selection of better nerves rapidly advanced so that today we are witnessing the very best results that can ever be expected in the realms of anastomosis in the surgical treatment of facial paralysis.

By the brilliant efforts of these and many others along similar lines, it has been definitely demonstrated that a successful anastomosis of a neighboring nerve to the facial nerve can restore the contour of the face in repose; and by education can, to a limited extent, bring about voluntary controlled facial movements. The nerves at first employed were the spinal accessory, the descendens noni, the hypoglossal, the glossopharyngeal.

It was discovered, too, that, with a few exceptions, the hypoglossal was more satisfactory than the spinal accessory; that, in turn, the glossopharyngeal was better than the hypoglossal. While improvement in the technique of these various anastomoses brought about better functional results, it was nevertheless noted that there remained two adverse factors to be considered. First, the

Fig. 4. Before operation, June 25, 1931.

Fig. 5. In repose, May 15, 1932.

Fig. 6. In action, May 15, 1932.

Fig. 7. Before decompression, March 10, 1932.

Fig. 8. In repose, three months later.

Fig. 9. Showing emotional response, three months later.

inevitable associated movements marred the results; and, second, even in the most successful cases there was an entire lack of emotional expression. And emotional expression, as we all know, is a very important element in the daily contacts of a human being.

In these circumstances, surgeons were still dissatisfied. In 1930, Sir Charles Ballance invited me to collaborate with him in an effort to improve the method of operative treatment of facial palsy. Aided by generous contributions from four foundations and a few

personal friends, we constructed an animal laboratory at my country place where we carried out our experiments. The result of our work, presented to the American Otological Society in June, 1931, was published in the *Archives of Otolaryngology* (2).

We carefully and conscientiously repeated all the anastomosis operations here mentioned. We added anastomosis with sensory nerves which was successful in restoring facial control marred by no associated movement.

But, motor restoration by this method remained slow and incomplete and again we were confronted by the fact that there was no emotional restoration. Gradually we evolved the idea that a direct repair might overcome these deficiencies. Hence we employed autoplastic grafts—bridging the gap from the proximal to the distal segment of the divided facial nerve, with grafts from the following nerves: (1) reversed facial, (2) external respiratory (Bell's), (3) intercostal, (4) descendens noni, (5) median cutaneous of the arm, and (6) great auricular.

In a large series of animals we were uniformly successful in restoring the facial function by introducing grafts taken from either motor or sensory nerves. Moreover, we demonstrated that we might use a graft of any length, reversed or unreversed, according to the demands of circumstances. Nevertheless in reporting the results of operations on these animals, we could make no categoric statement with regard to restoration of emotional expression. As far as we could judge, emotional expression of the comparatively limited nature exhibited by primates and cats was unimpaired; but not until we could operate for the benefit of humans could we be satisfied that this method of repair would meet all their higher requirements for the nuances of emotional expression.

I wish to state here that this is by no means an entirely new idea. It has long been known that the function of a divided nerve might be restored by the introduction of a graft into the gap; it has been employed in the soft parts for many years. Success, moreover, has followed upon the use of grafts in other regions much longer than any which could ever possibly be required in the repair of an injured facial nerve. The reason that it was not long before attempted was clearly because the facial nerve, in its course through the temporal bone, is enclosed in a bony tube of ivory-like density.

The idea of repair within the temporal bone had already been suggested by Ney (20), Martin (19), and Bunnell (7). As a matter of fact, the very idea of employing a long graft from the sural nerve was suggested by Dr. Bunnell, of San Francisco, in 1925. I have since learned that he actually employed such a graft in 1930 and that the operation resulted in partial recovery of facial function which is still improving. However, we were quite unaware of his work until it was called to our attention after the publication of our paper (2).

The accompanying pictures, taken from moving picture films made of 3 cases selected from a series of 13 cases, illustrate a wide variety of intratemporal repairs.

The first was a baby who suffered an accidental removal of 27 millimeters of facial nerve. This was repaired by a graft from Bell's anterior respiratory nerve, 48 hours after operation (Figs. 1, 2, 3).

The second was an adult patient. In this instance 30 millimeters of nerve was accidentally removed in the course of a radical operation. Repair was done 11 months after injury. Bell's anterior respiratory nerve, 30 millimeters, was excised and immediately transplanted (Figs. 4, 5, and 6).

The third film was made of a child who suffered an injury of the nerve by fracture and compression of the fallopian canal. The nerve was uncovered and the sheath was slit over an area of 10 millimeters. Decompression only was done. No graft was necessary (Figs. 7, 8, and 9).

With these and a number of other successes which I reported at the annual meeting of the American Laryngological, Rhinological and Otological Society (2), I believe that a method of dealing with facial palsy has been presented, which offers sufficient improvement over the methods of anastomosis of the facial with other nerves to warrant the discontinuance of that method except in very rare instances.

However, often while contemplating the manner of progress and the varying speed of improvement at different stages of the recovery in both animals and humans, certain phenomena kept obtruding themselves into my thought, arousing three questions for solution:

First, why, in all the grafted cases, was there a long period of inactivity, followed by a beginning slight response in the muscles, and then, directly after this, a rapid—almost tumultuous—improvement?

Second, why did this same phenomenon occur when the ends of a freshly severed nerve were simply brought together with no intervening graft; i.e., the same relative period of delay followed by beginning recovery, and then, tumultuous recovery—even though the actual elapsed time from injury to recovery might have been much shorter?

Third, why, when the graft was interposed, did the length of time of the delayed response vary according to the length of the graft? Why, after faint response first appeared, did the subsequent "tumultuous"—final, complete—recovery take place in about the same added time in all cases, regardless of whether the previous delay had been of short or long duration?

Now, the answer to all these queries is to be found in the stupendous and splendid research in nerve degeneration and regeneration which has been going on for 40 years. Even earlier than this, as far back as 1873, Létiévant (17), had done some work on the union of nerves which stimulated Ranvier (8) and Vanlair (8), Forssman (8), Ballance and Stewart (4) in this research. Then came a host of ardent workers, each adding much to the knowledge of the subject which, in its very nature, presented almost insuperable difficulties (8).

There developed two schools whose disciples agreed as to *what* took place—but *not* as to *how* it took place. The contestants have some of them been calm and open minded; others belligerent and unyielding.

Leaving out of the question for the moment *how* it takes place, *what* takes place is that a divided nerve suffers a "traumatic degeneration" for a short distance in the cut ends of both its proximal and distal segments. There is a slight difference in the two segments in this traumatic degeneration owing to the fact that the proximal segment is in direct communication with the so called trophic influences emanating from the central station, and, as a consequence, its wires or axons—or whatever you choose to call them—do not degenerate except for a short distance proximal to the place in the nerve trunk where the trauma has occurred.

The proximal axons multiply and try to push on out into the distal space hoping to make some connections, and do some work again. Many of these, failing to make connections, turn back—get "balled up" so to speak; hence the so called bulbous end of the proximal segment.

Now the distal segment undergoes a similar traumatic degeneration of the cut end which is necrotic in character; but, having no connection any longer with the central trophic influences, it makes no effort to function; there is no multiplication of axons; no bulbous end. In addition to this traumatic degeneration it undergoes another form of degeneration throughout its whole extent, right down to the terminal end plates, which transmit the nervous force to the muscle fibers.

This is called wallerian degeneration. What is wallerian degeneration? It is a very definite complicated process which begins at once in the distal segment of a nerve when it is cut off from its central station at any point. This may take place by a squeeze from toxic poisoning or inflammatory swelling as in Bell's palsy, or by actual division as in accidental trauma. When this happens, every last nerve cell in every axon disintegrates and finally disappears, leaving a system of tracts or tubes called bands of Buengner.

Now the question of how this takes place has caused a great deal of strife and difference of opinion. Volumes have been written about it. Suffice it to say that "digestive ferments," "enzymes," "chemical or electrical influences," bring about a granular and fatty degeneration, resulting in a mass of detritus in these tubes which, by invasion of phagocytes from the blood stream, is taken up and removed, finally leaving the cleared out tubes. These tubes then contain no nervous elements capable of transmitting nerve impulses. They are past that possibility when response to faradic stimulation ceases. In time these pathways are completely vacated and made ready to receive new axons from the proximal segment if they are permitted to enter.

What's to prevent them? Pus, fat, muscle, toxic products, foreign bodies, leucocytes, lymph in the scar. Do any of these impediments succeed in stopping all axons? Certainly not! Usually a few get by every obstacle but not in sufficient numbers to bring back muscular function.

When free passage is provided, they "shoot through" with incredible speed and eventually many of them form connections with the terminal end plates in the muscle fibers.

The degenerative process in the distal segment goes on for several weeks. The main part of it, however, is accomplished in 2 or 3 weeks. There is a time when the remaining products of degeneration in the distal segment are supposed to have a "chemotactic action," —a "come hither,"—an "attraction" for the axons of the proximal segment. They are supposed to orient them: to exert a *vis a fronte* from the distal segment, aiding the *vis a tergo* from the proximal segment. This chemotactic influence is supposed to be at its best about the end of the second week.

This observation was made by Ottorino Rossi who published an account of some clinical work he had done in Man, quoted by Cajal where he says (8) "the ideal graft is the peripheral stump, with bands of Buengner, newly taken from the animal operated on, 8 to 15 days after the operation. The newly formed fibers travel through it with an extraordinary speed, deviations and retrogressions being very much diminished. In order of effectiveness there then follow grafts of fresh nerves without bands of Buengner, and, finally, normal nerve segments which are preserved in a physiological salt solution under aseptic conditions." (Tello.)

However, the larger the animal and the larger and older the nerve, the longer the degenerative process takes. My own experiments on rhesus monkeys lead me to think that it takes about 3 weeks to clear the tracts sufficiently for the best clinical results.

At any rate, this process of clearing out of the tubes in the distal segment of a divided nerve takes place through the combination of chemical and circulatory influences very actively for a period of from 2 to 4 weeks, and continues less actively for a much longer time. And here one finds the answer to my questions about grafts.

When a nerve is divided and immediately reunited there follows a period of "hesitation" before recovery begins to be manifest, because this wallerian degeneration in the distal segment must take place, and the paths be at least partially cleared, before the new axons from the proximal segment can travel through. A fresh graft, excised from another nerve, is crowded with nerve cells which must "degenerate" and be cleared out in the same manner before new axons can pass through. This process, when the nerve graft is immediately transplanted, must be accomplished with the handicap of no circulatory apparatus at first, and only a poor one for some time. The graft must live on the fluids in which it is bathed and which are exuded from surrounding tissues, until it finally develops a circulatory system of its own.

In the meantime, the whole distal segment with its undisturbed circulation has gone through wallerian degeneration rapidly. Then, when the transplanted graft is finally cleared out sufficiently so that the axons from the proximal segment no longer impeded have pushed on through it, they are "received with open arms," at least with open tubes, by the distal segment. Hence the long delay while the graft is being traversed, finally followed by signs of slight improvement as some axons reach their terminal connections; and then "tumultuous" improvement as hundreds of others do the same.

Then, why will not cutting the nerve selected for graft material, and allowing the distal segment to degenerate for the proper time in its own environment with its undisturbed circulatory apparatus—just as happens in the distal segment of the facial—clear out the tubes, and render a graft which has been excised from it almost equal to the degenerated distal segment of the facial, as a conveyor of axons?

I have tried the plan on a number of rhesus monkeys and it works. I have "prepared" the anterior femoral cutaneous and the great auricular in this way. Degeneration has been allowed to take place for from 10 to 35 days. The protocol of the experiments follows:

PROTOCOL OF THE EXPERIMENTS

Autoplastic nerve grafts—"prepared" by degeneration *in situ*

Controls—fresh grafts

1. The anterior femoral cutaneous nerve
   - Single strand
     - Experiment 3—rhesus No. 8
     - Experiment 5—rhesus No. 11
     - Experiment 7—rhesus No. 17
   - Double strand
     - Experiment 1—rhesus No. 10
     - Experiment 2—rhesus No. 2
     - Experiment 4—rhesus No. 9
     - Experiment 8—rhesus No. 18
   - Two strands
     - Experiment 6—rhesus No. 16

2. The great auricular nerve
   - Single strand
     - Experiment 10—rhesus No. 13
     - Experiment 11—rhesus No. 14
     - Experiment 12—rhesus No. 25
   - Three strands
     - Experiment 9—rhesus No. 12
     - Experiment 13—rhesus No. 26

Control

1. Experiment 1
2. Experiment 9

Autoplastic nerve grafts. The nerves employed in these experiments were (1) the anterior femoral cutaneous nerve and (2) the great auricular nerve.

A. Control. A graft, freshly excised from another nerve was immediately placed in the gap between the proximal and distal segments of a dividend facial nerve. Varying lengths of gap determined by removal of segments of varying measured lengths of the facial nerve.

B. A graft from the distal segment of a similar nerve which had been previously "prepared." By "preparation" we mean that the nerve was divided. The distal segment was then left, undisturbed by dissection, in its own bed, for varying periods while it underwent wallerian degeneration, in exactly the same manner in which the distal segment of a facial nerve degenerates after division or injury.

These grafts, used as paths to convey axons from the proximal to the distal segment of the divided facial nerve, are taken from nerves which have undergone varying periods of degeneration to determine, if possible, at what stage of this degeneration they will prove most attractive to the axons; or, at least, present the minimum obstruction to their *vis a tergo*.

Note.—In a series of 22 rhesus monkeys the function of the facial nerve was ablated either by division, refrigeration, or injection of alcohol within the sheath, thereby causing immediate facial palsy as evidenced by loss of all voluntary, emotional, or reflex action. The distal segment was stimulated with the faradic current, at 12 to 24 hour intervals, to determine when muscular response disappeared. (Wallerian reaction of degeneration.) In 8 it disappeared in 24 hours; in 11 it disappeared in 60 to 72 hours; in 2 it disappeared in 96 hours. In 1 response persisted 9 days.

Experiment 1—rhesus No. 10, control.

48 hours. Complete loss of response in muscles of face to faradic stimulation. A double strand of the anterior femoral cutaneous nerve, 5 millimeters, inserted in gap.

44th day. Faint response to strong faradic stimulation in muscles of upper lip.

48th day. Faint response to strong faradic current in upper and lower lips.

63rd day. Faint response in nose and lips.

70th day. Facial tic in muscles around the mouth; greatly aggravated by faradic stimulation or conjunctival irritation. Winking reflex on threat and conjunctival irritation.

77th day. Tic very evident; no voluntary movements.

86th day. Response in muscles of lips to weak faradic current. Faint response in all muscles of face to strong faradic current.

95th day. Facial tic marked when animal is tied to table; violent on conjunctival irritation or faradic stimulation.

Note.—Difficult to differentiate between response to faradic stimulation and tic, as animal makes same responses when stirred up by stimulation on normal side.

121st day. Facial tic still marked. Response to strong faradic current in all muscles.

The tic is interesting in connection with the series of immediate grafts and various anastomoses recounted by Sir Charles Ballance and myself in our experiments reported in 1931. (Arch. Otolaryngol., 1932, Jan.).

Experiment 2—rhesus No. 2.

96 hours. Complete loss of response to faradic stimulation in muscles of the face. A double strand of the anterior femoral cutaneous nerve was prepared 10 days, 15 millimeters, and inserted in the gap.

22nd day. Faint response to strong faradic stimulation in the muscles of upper and lower lips. Tests at 2-day intervals showed only weak response in the same muscles up to the 43rd day.

43rd day. Distinctly better response in all the muscles around nose and mouth: faint response around eye.

49th day. Distinct improvement evident in all muscles.

55th day. Active response to weak faradic stimulation in all muscles.

57th day. Still improving; conjunctival reflex and threat reflex present.

61st day. Shows quick response in all muscles—voluntary and emotional responses very evident.

78th day. Very marked progressive improvement.

Experiment 3—rhesus No. 8.

48 hours. Complete loss of response to faradic stimulation in muscles of the face. A single strand of the anterior femoral cutaneous nerve, prepared 10 days, 7 millimeters, was inserted in the gap.

17th day. Weak response to strong faradic stimulation in the muscles of upper and lower lips and nose. Stimulation at 2 day intervals showed no definite change until

34th day. Definite response to strong faradic stimulation in all muscles of face.

44th day. Response to weak current around mouth, and to strong current in all other muscles.

55th day. Response to weak current in all muscles; conjunctival and threat reflexes in eye muscles; spontaneous movements.

73rd day. Marked progressive improvement.

87th day. Active conjunctival and threat reflexes. Faint response to weak current in all muscles. Facial tic in lower muscles of face: observed when animal is agitated and greatly aggravated by conjunctival irritation and faradic stimulation.

116th day. Facial tic still present. Response to weak faradic current improved in all muscles.

Experiment 4—rhesus No. 9.

48 hours. Complete loss of response in muscles of face to faradic stimulation. A double strand of the anterior femoral cutaneous nerve, prepared 11 days, 10 millimeters, was inserted in the gap.

14th day. Faint response to strong faradic stimulation in muscles of upper lip and nose.

30th day. Definite response to strong current in all muscles; conjunctival and threat reflexes in eye; spontaneous movements.

32nd day. Unfortunately the animal died from the anæsthetic. It was the most promising case in this series.

Experiment 5—rhesus No. 11.

65 hours. Complete loss of response in muscles of face to faradic stimulation. Single strand of anterior femoral cutaneous nerve, prepared 10 days, 6 millimeters, inserted in gap.

26th day. Faint response to strong faradic stimulation in muscles of upper and lower lips. Tests at 48 hour intervals for following 16 days showed no definite change.

43rd day. Response to weak current in muscles around mouth and nose; to strong faradic current in muscles of face.

57th day. Conjunctival and threat reflexes in eye; spontaneous movements.

62nd day. Marked improvement in all muscles of face.

68th day. Progressive improvement.

76th day. Fair response to weak faradic current in all muscles. Active conjunctival reflex. Facial tic in lower muscles of face.

96th day. Associated tic still marked on conjunctival irritation or faradic stimulation. Good response to strong faradic current.

111th day. Tic appears less evident. Muscular responses to faradic stimulation decidedly improved.

Experiment 6—rhesus No. 16.

68 hours. Complete loss of response in muscles of face to faradic stimulation. Two strands anterior femoral cutaneous nerve, prepared 14 days, 7 millimeters each, were inserted in the gaps; first to auriculotemporal, which had been accidentally divided; second to main branch.

26th day. Faint response to strong faradic stimulation in muscles of upper and lower lips.

38th day. Distinct response in all muscles of face to strong faradic stimulation.

45th day. No marked change.

70th day. Distinct response in muscles of upper and lower lips to weak faradic stimulation. Response in all muscles of face to strong faradic stimulation.

81st day. Conjunctival and threat reflexes in eye muscles. Facial tic in lower muscles of face—exaggerated by conjunctival irritation or faradic stimulation. Response in all muscles of face to weak faradic current.

87th day. Tic not as regular or as strong. All muscular responses rapidly improving.

Experiment 7—rhesus No. 17.

72 hours. Complete loss of response in muscles of face to faradic stimulation. A single strand of the anterior femoral cutaneous nerve, prepared 21 days, 12 millimeters, was inserted in the gap.

26th day. Faint response to strong faradic stimulation in upper and lower lips.

37th day. Faint response to strong faradic stimulation in muscles of upper and lower lips, and around nose.

51st day. Response in all muscles of face to strong faradic current.

63th day. Conjunctival and threat reflexes present. Facial tic appeared in lower muscles of face. Response in all muscles of face to weak faradic current.

73rd day. Conjunctival reflex active. Facial tic exaggerated by threat, irritation of conjunctiva, or faradic stimulation. All muscular responses were improving.

79th day. Facial tic not as regular or as strong. Muscular response to faradic stimulation improving rapidly.

Experiment 8—rhesus No. 18.

218 hours—9 days, 2 hours. Complete loss of response in facial muscles to faradic stimulation. A double strand of the anterior femoral cutaneous nerve, prepared 35 days, 8 millimeters, was inserted in the gap.

16th day. Faint response to strong faradic stimulation in all muscles. Weak conjunctival reflex, no threat reflex.

23rd day. No marked change.

51st day. Conjunctival reflex incomplete. Response in all muscles to strong faradic current improved. Weak faradic current causes response in muscles of upper and lower lips and nose.

59th day. Active conjunctival reflex. Facial tic in lower muscles of face. Response in all muscles of face to weak faradic current. Stimulation and conjunctival irritation exaggerate facial tic.

65th day. Facial tic decidedly less evident. Fair response in muscles of face to weak faradic current.

Experiment 9—rhesus No. 12. Control.

48 hours. Complete loss of response in muscles of face to faradic stimulation. Three strands of the great auricular nerve, 5 millimeters, was inserted in the gap. Stimulation with faradic current at short intervals gave no response in muscles of face until the fifty-first day following repair.

51st day. Weak response in all muscles to strong faradic stimulation. Faint conjunctival and threat reflex. A definite tic of the risorius at irregular intervals varying from a few seconds to a minute. The tic is exaggerated by faradic stimulation or conjunctival irritation.

64th day. Faradic response much more definite: the tic is still present.

70th day. Conditions same as on sixty-fourth day.

91st day. Faint response in all muscles of the face to strong faradic stimulation. Tic is so aggravated by stimulation that it is difficult to differentiate response to faradic stimulation from tic. Good conjunctival and threat reflexes.

119th day. Facial tic continues *pari passu* with improving muscular responses. Response to faradic stimulation improving.

Experiment 10—rhesus No. 13.

48 hours. Complete loss of response in muscles of face to faradic stimulation. A single strand of the great auricular nerve, prepared 10 days, 6 millimeters, was inserted in the gap.

48th day. Faint response to strong faradic stimulation in muscles of upper and lower lips.

54th day. Definite response to strong faradic stimulation in all face muscles. Conjunctival and threat reflexes.

61st day. Definite tic in the risorius; aggravated by faradic stimulation or conjunctival irritation.

67th day. Same reactions.

81st day. Facial tic increases when animal is restrained; also exaggerated by faradic stimulation or conjunctival irritation. Active conjunctival reflex. Voluntary movements. Excellent response in all muscles of face to strong faradic stimulation.

93rd day. Facial tic still marked. Fine response in all muscles of face to weak faradic stimulation.

109th day. Facial tic not so marked. All muscular responses steadily improving.

Experiment 11—rhesus No. 14.

47 hours. Complete loss of response in muscles of face to faradic stimulation. A single strand of the great auricular nerve, prepared 11 days, 7 millimeters, was inserted in the gap.

38th day. Faint response to strong faradic stimulation in upper and lower lips.

41st day. Response also in muscles of nose.

58th day. Response to strong faradic stimulation in all muscles of face; a definite tic in the risorius; conjunctival and threat reflexes. Tic exaggerated by faradic stimulation and conjunctival irritation.

65th day. All responses more definite; tic remains.

79th day. Vigorous response in all muscles of the face to strong faradic stimulation. Tic aggravated by restraint.

107th day. Fine response in all muscles of face to weak faradic stimulation. Tic remains but seems less regular.

Experiment 12—rhesus No. 25.

72 hours. Complete loss of response in muscles of face to faradic stimulation. A single strand of the great auricular nerve, prepared 21 days, 8 millimeters, was inserted in the gap.

17th day. Faint response to strong faradic stimulation in muscles of upper and lower lips.

26th day. Response to weak faradic stimulation in muscles of upper and lower lips. Response to strong faradic stimulation in all muscles of face.

33rd day. Responses in all muscles improving.

61st day. Fair response in all muscles of face to weak faradic stimulation.

Experiment 13—rhesus No. 26.

96 hours. Complete loss of response in muscles of face to faradic stimulation. Three strands of the great auricular nerve, prepared 21 days, 7 millimeters, were inserted respectively in gaps as follows: (a) from the proximal segment to the temporofacial branch; (b) from the proximal segment to the cervicofacial branch; (c) from the proximal segment to the buccinator branch.

16th day. Faint response to strong faradic stimulation in muscles of upper and lower lips.

25th day. Slight response to weak faradic stimulation in muscles of upper and lower lips. Response in the risorius to strong faradic stimulation.

32nd day. Definite response in all muscles to strong faradic stimulation.

54th day. Tests made at short intervals showing responses to faradic stimulation improving.

60th day. Conjunctival and threat reflexes present. Facial tic appeared in lower muscles of face. Aggravated by conjunctival irritation and faradic stimulation. Muscular responses to weak faradic stimulation in all muscles of face.

You will notice, on reading the protocol, that the muscular responses where the "prepared" grafts were used were obtained in a quarter to half the length of time required to obtain similar responses in the controls, where fresh grafts were used.

It would seem, from a study of these experiments so far as they have gone, that when autoplastic nerve grafts are employed to bridge gaps in a divided facial nerve, better results—both as to speed of recovery and more nearly normal restoration of function—may be expected if the graft material is "prepared" by division and degeneration of the nerve *in situ*.

It is safe to say that any graft which has been taken from a nerve "prepared" from 2 to 4 weeks, will probably be much more efficacious than a fresh graft. While any desired nerve may be so "prepared" and employed, I believe that the anterior femoral cutaneous is the best.

I have as yet used only fresh grafts in ten humans. I am now "preparing" the anterior femoral cutaneous which I propose to use, after 3 weeks' degeneration, in 2 cases of accidental palsies following mastoid operation, 1 of 4 years' duration and the other of 4 months' duration.

I believe that direct repair by transplantation of autoplastic grafts, either freshly excised or "prepared" as I have indicated, will supplant the method of anastomosis in all except the rare cases in which the facial palsy has been caused by intracranial injury or disease.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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LOYAL DAVIS, M.D.....Assistant Editor

DONALD C. BALFOUR, M.D.....Associate, Editorial Staff

FEBRUARY, 1933

THE 1932 CLINICAL CONGRESS IN ST. LOUIS

THE twenty-second annual Clinical Congress of the American College of Surgeons, held in St. Louis October 17–21, 1932—the first Clinical Congress held in that city—will be remembered as an outstanding success by reason of the large attendance, the widespread enthusiasm, a clinical program of exceptional merit and broad scope, and a series of scientific meetings and conferences that brought to the attention of the profession many notable contributions. A highly interesting program of operative clinics and demonstrations in thirty hospitals and two medical schools, that embraced all phases of general and special surgery, organized by the Committee on Arrangements under the leadership of Dr. Evarts A. Graham, chairman, was presented during the five-day session and received enthusiastically by the 2,000 visiting surgeons.

In the departments of ophthalmological and otolaryngological surgery special plans for the entertainment of the visiting surgeons resulted in a comprehensive clinical program emphasizing the important research work being done in St. Louis institutions. At two evening sessions eminent specialists in these fields presented important and timely papers to large and appreciative audiences.

Four symposia presented at the afternoon sessions were outstanding features of the Congress, and provided a number of notable contributions to our surgical knowledge. These symposia included: (1) "Cancer is Curable," with reports on five-year cures of different types of cancer by thirty eminent specialists in the various surgical fields; (2) "Treatment of Fractures," participated in by a group of surgeons of wide experience in this special field; (3) "Industrial Medicine and Traumatic Surgery," with papers and discussions dealing with the clinical and economic aspects of this important field, and a report of last year's survey of American industries by representatives of the College; (4) "Teaching of Surgery and the Surgical Specialties," which included a discussion of methods recommended for graduate and undergraduate instruction. The papers presented appear in this issue.

The program for the evening meetings, planned for audiences of varied interests, presented a group of papers of exceptional worth contributed by men of high standing in various fields of surgery. They attracted large audiences that crowded the ballroom to capacity. At the presidential meeting on Monday evening, the retiring president, Dr. Allen B. Kanavel, of Chicago, in speaking on the "Intangibles in Surgery," found in the philosophy and history of surgery the proper foundation on which to build for higher ideals. Dr. J. Bentley Squier, of New York, inaugurated as president, delivered an address dealing

definitely with the "Fundamentals of Specialism." Sir William I. DeCourcy Wheeler, of Dublin, Ireland, past president of the Royal College of Surgeons of Ireland, presented for the John B. Murphy oration in surgery an interesting talk on "Pillars of Surgery."

A symposium on thoracic surgery, another on intestinal surgery, together with a group of papers dealing with other surgical and gynecological subjects were interesting features of the meetings on Tuesday, Wednesday and Thursday evenings. The papers, by speakers from outside St. Louis with wide experience in their special fields, were short and well presented, with the use of many illustrations. These were discussed by local clinicians. In all of these the clinical aspects were especially emphasized, bringing to the members of the Congress many new ideas and added inspiration. The papers are published in this issue.

The beautiful ceremonial of the Convocation on Friday evening attracted an audience that filled the ballroom of the Jefferson Hotel to overflowing. A class of 633 new Fellows, coming from forty-three states, two provinces of Canada, and six foreign countries were admitted into fellowship in the College. Honorary fellowships were bestowed on two distinguished visitors: Sir George Lenthal Cheatle, London, England; and Dr. José Goyanes, professor of surgery in the National Academy of Medicine of Madrid, Spain.

In his presidential address, Dr. Squier reviewed in detail the accomplishments of the College during twenty years and contributed suggestions as to its future activities. The fellowship address by Professor Robert A. Millikan, director of the Norman Bridge Laboratory of Physics, California Institute of Technology, gave a highly interesting presentation of "Some New Things in Physics."

An audience of 10,000 attended the Community Health Meeting on Wednesday evening crowding to its limit the gymnasium of St. Louis University and overflowing into and filling to capacity the auditorium of the law school of the same university. It was estimated that in addition 10,000 people were turned away unable to gain admittance to either of these halls. Twelve speakers presented to this vast audience the aims and objects of the American College of Surgeons, told of the contribution of scientific medicine to the progress of the civilized world, described modern hospitals, spoke of specific diseases and their symptoms, such as cancer, appendicitis, backache, nervousness, etc. These vast audiences evidenced the avidity on the part of the public for reliable information on matters pertaining to personal health—ample justification for the continuance of the College's educational program under which community health meetings have been held in 111 cities of the United States and Canada since 1920. As a part of the program health talks were given in St. Louis by speakers for the College to the students of ten high schools, members of twelve clubs, and a vast invisible audience through fifty-seven radio broadcasts.

The annual hospital standardization conference, with a four-day program, presented many valuable discussions of vital problems concerning administrative and professional matters with emphasis on hospital economics. A unique feature was carried out on the closing day—the presentation in two hospitals of a series of practical demonstrations in hospital administration. A summary of the results of the conference would include: (1) A better appreciation of standardization principles and their practical application; (2) a clearer understanding of the hospital's internal and external relations; (3) a further contribution to our knowledge of the application of business methods as a means of meeting present day economic problems.

A well organized and adequately manned press bureau worked in close co-operation with the local newspapers and the great international press associations to provide an adequate report of the proceedings of the Congress. Recognizing the importance of such a gathering and the opportunity for the dissemination of news of important advancements in medical science, out of town newspapers sent special representatives. The result was that the press of the country at large carried each day comprehensive and well written articles that reflected credit upon the College and its accomplishments.

CONFERENCE ON CURABILITY OF CANCER

WHEN thirty of the eminent surgical specialists of the country assemble and tell of their cases of cancer that have lived five years and more following treatment, the total of their successes assumes a proportion that must give renewed stimulus and confidence to the surgeon, justification for increased hope on the part of the patient with cancer, decision to apply for early treatment when cancer is suspected, and a brighter general outlook for the future in the cancer field.

The conference on the Curability of Cancer held during the 1932 Clinical Congress of the American College of Surgeons must perforce produce such results. Surely the more than thirty thousand added years of health represented by the reports (of their own cases) given by these surgeons must command the attention of one attempting to appraise the value of the work of the medical profession. This is no exaggeration, for the average duration of life in untreated cancer cases is usually estimated at two and one-half years, and the four thousand three hundred forty-four patients reported by these surgeons are known to have lived in good health from five to thirty years following treatment.

Some of the speakers at this conference presented good and valid reasons why the interest of the medical profession in the advanced cases of cancer should be increased. Occasional unexpected responses to therapy and the relief that can be afforded to the majority of these patients by surgical, radiological, or medical palliative measures urgently bespeak an active and confident attitude on the part of the medical profession toward the late cases of cancer.

While it is well known that cancer on the superficial parts of the body as a rule is recognized at an earlier stage and therefore gives better statistical results, in a survey of the program of this meeting the attention is captivated by its inclusiveness which demonstrates the successful application of therapeutic methods even to those parts of the body which are the most difficult to approach.

Another interesting phase of this conference was its forceful refutation of the alleged soullessness of the modern clinic. The introduction of accurate records, and of complete follow-up data, which are made possible by the utilization of social service workers, has made it possible for the surgeon to maintain close supervision of his patient and to know the condition of that patient over periods up to thirty years.

It is hoped that one result of this conference will be the stimulus offered to the medical profession to make use of the methods of diagnosis and treatment which have been shown to be successful; and by earlier and more effective application of these methods, to other cancer cases to increase manifold the number of cures of this disease.

ROBERT B. GREENOUGH.
BOWMAN C. CROWELL.

PRESIDENTIAL MEETING, CONVOCATION

ADDRESS OF WELCOME[1]

EVARTS A. GRAHAM, M.D., F.A.C.S., St. Louis, Missouri

ST. LOUIS is pleased to welcome the Clinical Congress of the American College of Surgeons. We hope that this first visit to this city will prove interesting and pleasant enough to warrant a return. To many of our eastern friends the Mississippi River still marks the edge of the frontier as it did at the time that Lewis and Clark started from here on their famous expedition to explore the Northwest Territory. We hope, however, that after the week of medical activities no one will feel that St. Louis is still a frontier town in a medical sense, despite its location on the western side of the Father of Waters. The two medical schools and the many fine hospitals feel that they can be justly proud of their accomplishments. St. Louis was one of the first cities of the country to develop modern university medical education, and the standards and methods established here have served as models to many of the more recent extensive educational developments in other parts of this country and to some extent in other countries. Although the realization of our plans has not been completed—in fact no scheme of education can ever properly be considered completed—we invite you to join with the group of visitors from all parts of the world, interested in medical education, who have come here to investigate at first hand what we are attempting to accomplish. St. Louis is said to be a city surrounded by the United States. It is not Eastern, Western, Northern, or Southern. It has perhaps some of the attributes of all sections of the country. We like to think that from the South we have taken over the characteristic feature of hospitality, and I hope that this good side of us will be in evidence this week.

[1]Presented before the Clinical Congress of the American College of Surgeons, St. Louis, Missouri, October 17–21, 1932.

INTANGIBLES IN SURGERY[1]

ALLEN B. KANAVEL, M.D., F.A.C.S., Chicago

IN our commendable endeavor as an organization to elevate the practice of surgery, we may well pause to consider if, in our emphasis upon technical training, standardization of teaching and practice, and study of economic factors in medicine, we are not overshadowing the intangible qualities that have made surgery a growing science and an increasing art. An organism may be perfect anatomically but it needs the elusive spark of life to give it being. Ideals, self-sacrifice, personal and professional honesty, love of the search for knowledge, culture, judgment, common sense, and imagination may not be ponderable but nevertheless their presence marks difference between technical efficiency and greatness.

In this day of commercialism, political crassness, and Freudian complexes, the ideals and aspirations of the physician and scientist come as a breath of fresh air in a musty room. The commercial world exalts those who accumulate wealth; the political deifies the narrow-minded nationalist; and the unthinking citizen finds his hero in the banalities of the moving picture theater. Medicine engrossed in scientific investigation and its application to the relief of human suffering, reserves its insignia of greatness for those who find their satisfaction in service and in the search for the elusive secrets that benefit mankind.

The American College of Surgeons was founded upon the ideal of disinterested service. The permanent accomplishments of the College depend upon the measure of devotion of each fellow to this basic principle. This ideal is a part of our heritage. Guy de Chauliac, the father of surgery,

[1]Address of the Retiring President, presented before the Clinical Congress of the American College of Surgeons, St. Louis, October 17, 1932.

said the surgeon should be "modest, dignified, gentle and merciful, not covetous nor an extortionist of money, rather let his rewards be according to his work, to the means of the patient, to the quality of the issue, and his own dignity." Paracelsus, two centuries later, said that the "physician shall study daily and learn from the experience of others. . . . He shall at all times be temperate, serious, chaste, living rightly, and not a boaster. He shall consider the necessity of the sick rather than his own; his art rather than his fee."

The unthinking public, accepting its opinions ready made from the tabloid newspaper, the smoking compartment of the Pullman, and teacup gossip, presumes to judge the qualifications and standing of the physician. The clever carpenter in surgery, the facile adaptor of diagnostic principles, and the self-confident therapist may attain an ephemeral eminence, but the calm, flowing and relentless stream of time leaves standing only our Pasteurs, Listers, and Hunters—our idealists, imbued with self-sacrifice, honesty, industry, learning, and gifted with judgment and imagination. The men we honor go their way with equal happiness in daylight and darkness, sacrifice comfort, home, and even life itself in their devotion to their chosen calling. Mawkish sentimentalists bewail the laboratory use of animals that has saved tens of thousands of human lives, but forget that the physician has been just as willing to use his own body as a human test tube or culture medium; that Senn transplanted to his own body cancer cells to disprove their transmissibility, that Lazear by the loss of his life demonstrated the cause of yellow fever, and that Ricketts by a similar sacrifice proved the source of typhus fever.

Incorruptible honesty in scientific investigation and in our relations to patients and the community must be the foundation of our work. No surgeon can be truly great if he deceives himself or the public. He should never administer treatment except after painstaking study of the patient, his disease, and his bodily resistance, and only after he is convinced that he would accept the same advice for himself or his family. He should not undertake surgical intervention unless he is competent to treat not alone the specific condition attacked but also any complications that may arise. Any operation performed at the request of colleagues without personal study and justification shows not only intellectual laziness, but culpable acquiescence. Those who would barter their inheritance of disinterested service for money or let it influence their judgment should not forget that Judas' thirty pieces of silver bought only a potter's field.

The little surgeon hastens to report his successful experiences; the great surgeon is more concerned with his failures. Sims reported twelve failures on a single patient before he discovered the principles of the treatment of vesicovaginal fistula. Fenger was as careful to publish the fact that the first six patients upon whom he performed hysterectomy died, as he was to present his great work on stones in the common bile duct. Mott did not fear to announce a fatality from his first attempt to ligate the innominate artery. These men had good precedent, however, for of the forty-two clinical cases reported by Hippocrates, sixty per cent had a fatal termination. "I have written this down deliberately," says Hippocrates, "believing it as valuable to learn of unsuccessful experiments and to know the cause of failure."

The great surgeon, in common with all scientists, loves to wrest from nature its secrets for the pure joy of increasing knowledge. He may be oblivious of its immediate application, but he is confident of its ultimate benefit to mankind. Franklin's apt rejoinder, "what is the use of a baby," to a critic of pure scientific investigation is a complete answer to those who demand immediate results from such studies. Ramsey and Ranleigh discovered invisible gases by using a microbalance that would detect a difference in weight of one-fourteen billionth of an ounce, and by substituting one of these for nitrogen helped to prevent the "bends" in caisson workers. Dalton made two hundred thousand observations on the atmosphere, and in studying the composition of air, arrived at the atomic theory. Resting on Dalton's assumption, Priestley obtained pure nitrous oxide and Davy discovered its physiological effects so beneficent in the practice of medicine. Insulin, adrenalin, toxins and antitoxins, asepsis and antisepsis, all surgical and medical procedures, have back of them a dim but glorious procession of physicians and investigators who have devoted their lives to unraveling the tangle of nature. It is to these restless spirits of insatiable curiosity that medicine owes its debt, much more than to the facile adaptors of other men's ideas.

The physician must be industrious. He must submerge his life in his profession and the lives of his patients. Medicine is a jealous mistress. She brooks no rivalry with business, art, or social life. Gross wrote his great surgery while being driven about to make calls upon his patients. Ehrlich tried six hundred and five chemical combinations

before discovering salvarsan. The Curies searched through a ton of pitchblende to find a few crystals of radium. The great among us are driven by this dominating passion and are not content to whisper their *Nunc Dimittis*, "Now let thy servant depart in peace," until they have added something of permanent value to the storehouse of surgical knowledge. This is not with the hope of immediate fame but with the laudable desire to be associated, even in a small way, with the brilliant procession of physicians stretching back into dim antiquity who have enriched science and served humanity. Industry and knowledge beget modesty and few great surgeons could be psycho-analyzed as having a superiority complex.

A familiarity with the history of medicine and cultural literature is essential to the great surgeon. Hippocrates said, "An important phase of the practice of medicine is the ability to appraise its literature correctly." The trite expression "beacon lights of history" suggests the proper application of medical literature and history. It should warn us of the rocks and shoals to be avoided; indicate the clear channels of thought through which our course may be charted into the broad ocean of undiscovered knowledge where experiment, adventure into new waters of imagination, may bring fruitful results. The mantle of Elijah does not fall upon the ignorant man. Culture safeguards our scientific studies, broadens our medical horizon, and gives joyous communion with the creative minds that have gone before. The surgeon cannot be truly great unless he loves literature, history, and the cultural arts that stimulate, develop, and enrich the inner man.

Narrow mindedness is the offspring of lack of culture and literary perspective. Productive experimentation is not blind chance but constructive hypothesis based upon knowledge. When Becher introduced the theory of phlogiston as an element of fire to explain burning, oxidation, and calcination—he retarded science for a century. It was theory without basic knowledge. Unfortunately, we still repeat the same error in modern medicine. Our carpenter gastropexies, our short circuiting operations for gastroptosis advocated without physiological knowledge, and our abandoned drugs introduced by empirical rather than scientific methods, are not far enough from the bezoar stones, electrical belts, and the manipulations of the quack to save us from a measure of just criticism.

Judgment and common sense are inherent qualities, but they may be improved by thought and study. Not infrequently we see too ready acceptance of theoretical procedures and advertised nostrums, operations advocated without adequate analysis of the dangers and complications, and surgical procedures instituted without due consideration of the resistance of the patient and the physiological result. The surgeon who rushes to introduce selective "free wheeling," "dual control," and the "high compression" motor into his practice is seldom the great leader of his profession. It is true that this ill advised haste more often arises from thoughtless enthusiasm than dishonesty, but it does show a lack of judgment. The use of new clinical procedures should be preceded by physiological study, their value verified by careful experimentation, and their employment dictated by judgment and common sense. Our surgical highway is strewn with discredited diagnostic procedures, discarded anæsthetics, and non-physiological operative procedures. We think of Paré as the imaginative surgeon, but one has only to read the delightful description of his treatment of the compound infected fracture of the Marquis d'Auret, to realize that he was endowed with superlative judgment and common sense. In this day of futurists and cultists in medicine, as well as the arts, let us not forget that common sense is the basis of all good surgery.

Nothing vitiates judgment and common sense more than the tyranny of the fixed idea. The surgeon should not be a cinematographic automaton. Open-mindedness is probably the hardest quality to maintain. Several centuries ago Roger Bacon said the causes of human error were undue regard for authority, habit, prejudice, and the false conceit of knowledge; and Turgot, "It is not error that opposes the progress of truth. It is indolence, obstinacy, the spirit of routine and everything that favors inaction." The little surgeon with his fixed ideas institutes procedures cemented by authority or habit, cannot meet in a constructive way new or unexpected conditions, does his gastro-enterostomy for all ulcers of the stomach, uses the same anæsthetic for all cases, treats his fractures by the same routine method, always does the "Smith" or "Jones" operation in a given condition without having the pliability of mind or imagination to modify it to meet the varying conditions. All science suffers from this blight. Lavoisier's head had already fallen from the guillotine before Priestley acknowledged the possible truth that burning was the union of the consumed substance with oxygen. Berzelius' classic contribution upon nitrous oxide was refused publication by the Academy of Science because "they did not approve the new chemical nomenclature" of Lavoisier which he had dared to use.

Our institutions of learning too often teach standardized courses, foster the groove mind, and find it difficult to encourage the genius in special lines. Berzelius, the Swedish chemist, was warned on his graduation day that there was no hope that he would do anything creditable since he had cut his Hebrew courses. Liebig was expelled from school with the statement that he was "hopelessly useless," because an explosion occurred while he was devoting his time to some original experiments with fulminic acid, and John Hunter was the despair of his parents and teachers because he preferred to study nature in the woods rather than from books.

Imagination is the quality that raises us above mediocrity. It is not the peculiar attribute of the educated man. The Melanesians, before the advent of Cook, used the freshly cut and peeled branch of a tree as an intramedullary splint in fractures. The plaster cast had its origin in the practices of the African savage. To imagination science owes its progress. Avogadro had no balance to weigh his molecule, no microscope to see it, no chemical reaction to prove it. It was a pure fabrication of his brain but justified by the fact that it explained known facts and was the solid foundation for new conceptions. Mendeléjeff's periodic table of elements and Moseley's X-ray spectroscopic prophesy and proof of ninety-two elements, were imaginative conceptions resulting from an almost fanatic devotion to intense investigation. Langmuir's conception of the structure of the atom may one day make real the alchemist's dream of transmitting lead into gold. The imaginative scientist assumes majestic stature in comparison with those who follow meekly the blazed paths of life.

The history of medicine is the history of imagination—first superstition, then concepts evolved from known facts, and finally experimental, laboratory, and clinical verification of theory. Paré's ligature, Lister's antisepsis, Morton's and Long's anæsthesia, are but three of the thousands of milestones that mark the path of imagination that great physicians have trod. Pasteur has said: "Without theory practice is but routine born of habit. Theory alone is able to call into being and develop the spirit of invention."

The American College of Surgeons is interested not alone in assuring competent care to the sick but also in advancing the frontiers of medical knowledge. In our intense study of the obvious and practical we should not neglect to emphasize that unselfish service, personal and professional honesty, the urge to seek new truths, industry, broad culture, judgment, and imagination, even more than technical efficiency, are the qualities that have given American surgeons an enviable position in international surgery. It is these that inspired McDowell when he did his first ovariotomy, Post when he first tied the femoral artery for popliteal aneurysm, and Beaumont when he investigated the function of the stomach on Alexis St. Martin. It is these that made Dudley, Mott, Brashear, Jameson, Wyman, and Sims trail-markers in the surgery of the new world. It is these that brought fame to our Senns, Fengers, Murphys, to our Bulls, Warrens, Agnews; that inspired our Mayos, Criles, and Martins.

Technical dexterity in surgery is but the vehicle for the translation of these intangible qualities into surgical eminence. Elusive though they may be, they alone lead to enduring fame.

I paraphrase for you this sentence of Renan's: "Fame is a great coquette. She will not be sought too passionately, but often is most responsive to indifference. She escapes when she seems to be caught, she surrenders if patiently waited for, showing herself after farewells have been taken but inexorable when loved too ardently."

FUNDAMENTALS OF SPECIALISM[1]

J. BENTLEY SQUIER, M.D., F.A.C.S., NEW YORK

IN earliest recorded history the physician was priest, magician, and medicine man. As human intelligence advanced to higher levels he was forced to split up his activities and declare himself. Some became priests, some charlatans, and others medical men.

In Egypt, sixteen centuries before the advent of Christ, this had already happened. But in other parts of the world, where intellectual processes were slower in unfolding, it did not occur until many centuries later. When Herodotus made his much exploited journey he found medical men even then further concentrating their endeavors for there was a special physician for almost every disease. The so called overspecialization of modern medicine might therefore be considered a reversion to type, possessing, at least, a precedent in antiquity.

The passing of the "old time" practitioner has been made a subject of much lamentation, and, from a purely sentimental angle, deservedly, for embodying as he often did, the attributes of friend, priest and physician, he held a very personal relation to his patient and his virtues have been loudly extolled. The paucity of his scientific information was offset by a great breadth of character and a wealth of human understanding. These qualities will ever remain the most distinguishing signs of greatness in any physician of whatever period. We pride ourselves upon the prodigious developments of theoretical and applied science which the past fifty years have produced, but in the minds of many exists a grave doubt as to how greatly all of these have added to the total of human happiness.

Every new step on the path of knowledge had opened to our vision uncharted deserts of human ignorance. If the goal of scientific progress is the production of human happiness, we of today may become objects of severe criticism fifty years hence for not having better utilized the scientific discoveries of this generation. It behooves us then to acquire the "old time" doctor's human understanding, kindly disposition, and humble attitude, for these are fundamentals of our calling, and also in order to neutralize any criticism of our own shortcomings which in years to come is bound to be made.

It is still within the ken of the older generation when a specialist in medicine was looked upon askance—as if possessing mental obliquity. But the passing of years has effaced that view and now specialization within medicine has become as necessary as specialization in every other branch of science or profession. In engineering there are chemical, civil, electrical, and mechanical engineers. In law, there are those who devote themselves to banking, civil, corporate, or criminal law, and so forth.

For as the world has aged, knowledge has increased to such an extent that it is now beyond human intelligence for any one individual to learn in the short span of life but a part of the existing information concerning any science or profession. To attain proficiency necessitates concentration upon a limited field and any improvement brought to this end will be beneficial to all. Every outstanding advance in medicine has resulted from intensified effort on one problem, the solution to which has opened the way to further progress.

It is to be regretted that the thought still exists in the minds of many that when a physician becomes a specialist he at once lays claim to superior proficiency. Whereas, by limiting his work he is but making a laudable effort to acquire proficiency.

The division of physicians into two main groups, one interested in medicine the other in surgery, has given rise to much misunderstanding. This grouping has developed from a difference in indicated therapy and not from a difference in medical thought. In the final analysis, surgery is but a therapeutic measure for the treatment of certain diseases, injuries, or the correction of deformities and so on. An expenditure of more time and effort is required to learn how skillfully to administer surgical therapy than to administer a dose of medicine, but to be able to determine which type of therapy should be used requires similar fundamental knowledge.

The surgical remedy, however, frequently necessitates adding injury to the tissues of the body by wound production, thereby injecting a second healing problem. The surgeon must heal the patient of the wound as well as the disease. During the course of this wound healing many complications may develop which require extensive medical knowledge in order to treat them intelligently. The patient may succumb to the disease or to complications arising directly or indirectly from the administration of the surgical

[1]Inaugural Address, presented before the Clinical Congress of the American College of Surgeons, St. Louis, Missouri, October 17-21, 1933.

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remedy. The surgeon then has to share with disease the responsibility of death; while in the purely medical care of the sick if one remedy fails others are forthcoming, or if all fail the demise of the patient becomes an act of fate. Not so in surgery, for the psychology of people is such that in their minds the thought lingers that if another remedy had been used or another surgeon had been in charge the result might have been different. The reverse of this, however, is stimulating, for when surgical therapy is successful in effecting a cure it becomes more a testimony to the personal excellence of the surgeon than to the therapy instituted, for his service has been definite, individualistic, and in no manner speculative.

He will be judged absolutely upon the outcome of his own act and he must be in a position to justify it at every angle. A surgeon, therefore, should possess not only the technical skill properly to administer the surgical remedy but should be capable also of recognizing the possible presence of coexistent pathological lesions in any patient. He should be able to evaluate the influence for or against surgical interference which added lesions may produce. If the surgeon has to rely upon the judgment of others for this knowledge, he has not the proper conception of his responsibility.

This is but further endorsement of the time worn adage—"To be a good surgeon one must first become a good physician." A good surgeon must combine the qualities of both. Changing times will never vary the wisdom of this advice, but in the hurry of every day life to become producers, many disregard it in an effort to make a short cut to economic success. The attention of such individuals should be directed to the facts elicited by a survey of the earning capacity of the profession compiled by the American Medical Association. It brought out that the largest gross incomes are made by physicians who have spent ten or more years in preparation and the low gross incomes are among the physicians who have had three years or less of preparation.

The road to the attainment of excellence in any branch of medicine or surgery is the same long route. The student in starting to follow this route soon finds it a maze. He becomes confused by the chaos existing in undergraduate medical education. This chaos has been produced by the tremendous mass of new information which the past fifty years have brought to all branches of science. Men have been intellectually unequipped to make proper use of it. In an attempt to keep abreast of the rapid strides of modern medicine, the faculties of medical schools have added new requirements and subjects to the curriculum to such an extent that it is almost impossible for the student to acquire during his undergraduate course more than a smattering knowledge concerning many of them. The Commission on Medical Education of the Association of American Medical Colleges has been trying since 1925 to arrive at a sensible solution of this increasingly difficult problem. That they will succeed is certain, but in the meanwhile the student on his way to licentiate in medicine plods wearily on.

The overcrowded curriculum may, however, be of use if it produces in the student's mind a realization of the vast amount of mental exertion necessary to acquire a working knowledge of the science of medicine. For he must understand that he is not learning a trade and if he is to become learned in his profession will have to continue to study until the last of his working days.

It is my belief that before deciding to take up any one specialty in medicine or surgery, a recent graduate should be required to spend two years as an interne in the medical service of a hospital. If, during this period, he can find time to study psychology he will never regret the extra effort, for all through his future professional life it will enable him better to understand a patient's viewpoint. It will also help him more easily to establish mental contact with a patient and thus more quickly gain the patient's confidence.

The reason for insistance upon preliminary medical interneship is based upon many factors. An individual can never be sure that he will be able to fit into the specialty of medicine of his ambition. He may be unable to earn a living at it and be forced to select another.

Only about 15 per cent of patients require the services of specialists and it is wise for every physician to have had a preliminary hospital interneship which gives broad medical training in order to readily adjust himself to unforeseen circumstances.

Having finished his medical service he is then ready for surgical training. If he elects general surgery two more years should be spent in the general surgical wards followed by a surgical fellowship of at least one year before being allowed to practice surgery. If he elects a surgical specialty he should devote at least one year to study in the general surgical wards and then two years in the wards of the elected specialty. This makes five years spent in hospital training and it may appear a lengthy apprenticeship prior to commencing practice, but better than curtailment, would be to reduce the time spent in acquiring

the academic requirements for admission to the undergraduate medical school. A student of medicine should be allowed to commence the study at an earlier age, so that he may still be in the impressionable years when his first contact with patients takes place. Place responsibility upon his shoulders early for it sooner makes him able to meet it.

The medical professions are now separated into groups variously devoted to experimental, research, preventive, teaching, and clinical medicine, hospital administration, public health service, sociology, etc. Medical service is being considered from a much wider angle. Society is insisting upon a more effective organization of medical service for the people as a whole rather than as individuals. This being the case, readjustments in medical education are unavoidable. Progress has created new responsibilities which fall not upon governments but on those who are masters of scientific method, the physicians themselves, and must be shouldered by them, if the profession is to retain its autonomy and independence. This situation has been only partly recognized by the profession even though considerable energy is being expended toward making opportunities for extension or graduate training for those desiring to enter any special group. Graduate education is the question of the hour, and universities, hospitals, county medical societies, and academies of medicine are endeavoring to create and meet demand for it.

The necessity for a continuing education is, of course, not new to the Fellows of this organization because an appreciation of this necessity actuated its formation. However, with the increasing opportunities for graduate training, a conviction has arisen, both within and without the profession, that some means should be taken to compel those who practice as specialists to have had adequate training to warrant them in making use of such an appellation. This was most forcibly stated in the biennial survey of education made by Willard C. Rappleye for the Department of the Interior of the United States Government in 1928 and 1930. One of the concluding paragraphs of his report on medical education was as follows: "The training of specialists is another phase of the larger problems of training personnel to meet the medical needs of the country. The time will come when the medical profession and the public authorities will devise ways and means of guaranteeing to the public that those who claim to be specialists are, in fact, competent by training and experience to perform the service they claim to be able to render."

This conviction is not limited to our country but is world wide, and certain European nations have made definite progress toward legalization of specialists. Although bills have been introduced in some of our States with a view to legalization of specialists, I believe it will be a sad commentary on the profession if further licensing by the government becomes necessary. There exists within this College the potentialities for the solution of this problem.

Universities are appreciating that definite courses for advanced study in medicine and surgery should be offered—leading to acquisition of special knowledge sufficient to justify a physician taking such courses to enter the practice of a specialty. Columbia University grants recognition for acceptable work in the clinical specialties by means of a degree of Master of Science. This degree does not designate to which special field of study the student has devoted himself. The requirements for the degree are broad in order to permit of flexibility in training for the various specialties. The requirements for admission to study for the degree are evidence of graduation from an approved medical school and the completion of an interneship of not less than one year after graduation. The course extends over three years in the University or in hospitals recognized by it, at least one year of which must be spent in the University. Intensive study in anatomy, embriyology, physiology, pathology, bacteriology, and in other fields of science is required, as well as an active experience during the three year period of not less than eighteen months spent in the hospital, clinics, and diagnostic laboratories of the specialty elected. One university having initiated this others will join in supplying similar courses leading to a degree or otherwise.

The time is propitious and opportune for the American College of Surgeons to undertake another great work, which will become as far reaching in beneficial effect as that of standardization of hospitals. I would suggest, therefore, that from the already appointed committee on Graduate and Under-Graduate Teaching of Surgery and the Specialties the College institute a forum for discussion of graduate medical educational problems. To this forum should be invited Fellows of the College who are teaching in institutions where graduate medicine is a part of the curriculum. Representation should also be requested from the Association of American Medical Colleges. By interchange of ideas, and using the University requirements leading to the degree of Master of Science as a basis for discussion, definite standards should be determined for

graduate training in every clinical surgical specialty. This training should be so comprehensive that there could be no shadow of doubt about a physician, who had been so trained, being able to qualify as a specialist in that branch of surgery in which he had majored. These standards of training having been formulated, ways should be devised to supply them, as well as means to have them made easily accessible to physicians in different localities. Supplying the courses of training should not present difficulties, for on the roster of the Fellows of the American College of Surgeons are over ten thousand surgeons and surgical specialists, and the teachers of surgery and its specialties in the Universities, medical schools, and hospitals of the United States are with few exceptions Fellows of the College. Enlisting their aid and enthusiasm and by careful co-ordination, similar courses, technical and other experience could be made available in a multitude of centers. A merger of all approved agencies for graduate medical teaching in a labor of this kind, would effect a correlated educational program and would prevent the occurrence of chaos in graduate instruction which has been such a source of confusion in undergraduate training. The recent graduate from a medical school has a year or so of hospital interneship, but even then is without definite ideas as to how to fit himself for special practice.

The College having determined standards of training for special practice and having inspired making the acquisition of them accessible, will be in a position properly to guide such an individual.

The College will become the supreme court for evaluating the excellence of the courses given in all centers of graduate training, and its assumption of this leadership will prove a most effective stimulus toward furthering graduate study in every branch of medicine or surgery.

There is one step further for the College to take—the most important step—and that step is making it imperative for every future member of the junior candidate group to acquire this fundamental training. For the sake of argument, let us suppose that the requirements which the College has agreed upon are very comparable to the requirements for the degree of Master of Science. The junior candidate will have seven years before becoming eligible to Fellowship, in which to acquire the knowledge and experience which by intensive study the Master of Science must acquire in three years. Many of the courses could be taken in different periods and in different institutions, and upon successful completion of any prescribed course a certificate would be given testifying to the fact by the institution in which the course was taken. When the candidate has received certificates of successful completion of all training requirements, then upon submission of the one hundred acceptable case records at present demanded, he is eligible for Fellowship.

For, as in the ancient days the public forced the medical men to declare themselves as either priest, thaumaturge, or medicine man, so in the future will it become incumbent for physicians to declare which branch of medicine they are qualified by adequate training to practice, with the added obligation of supplying a guarantee.

Let us make Fellowship in the American College of Surgeons the guarantee to the public that a physician possessing such Fellowship has received the proper fundamental training and experience to qualify as a specialist.

PRESENTATION OF HONORARY FELLOWS

FRANKLIN H. MARTIN, M.D., F.A.C.S., CHICAGO

AT the Convocation on Friday evening Honorary Fellowships were conferred by the President on the following eminent surgeons:

Sir George Lenthal Cheatle, London, England; Eminent Surgeon; Knight Commander, Order of the Bath; Commander, Royal Victorian Order; Fellow Royal College of Surgeons, England; Walker Prizeman, 1926–1931; Consulting Surgeon and Emeritus Lecturer in Surgery, Kings College Hospital. Introduced by Dr. C. Gordon Heyd.

Professor José Goyanes C., Madrid, Spain; Distinguished Doctor of Medicine and Surgery; Author and Philosopher; Professor of Surgery to the General Hospital of Madrid; Founder and President of the Society of Surgery of Madrid; Member of the National Academy of Medicine; Doctor Honoris Causa of the University of Bordeaux. Introduced by Dr. Rudolph Matas.

PRESENTATION OF CANDIDATES—CLASS OF 1932

FRANKLIN H. MARTIN, M.D., F.A.C.S., CHICAGO

IN behalf of the Board of Regents of the American College of Surgeons, I have the honor to present for Fellowship in the College candidates as follows:

United States	623
Canada	2
Alaska	1
Porto Rico	1
Australia	1
Costa Rica	1
Cuba	1
Korea	1
Persia	1
Republic of Panama	1
Total	633

Each year as we receive a new class of candidates into Fellowship, I am impressed by the prestige of an institution that can influence such a goodly number of busy practitioners of surgery to seek its portals.

To the casual observer these men and women appear as one more group that is being enrolled into our ranks. Complacently, this observer shrugs his shoulders and reflects: "How easy!"

As an illustration let us enumerate the following facts:

There were 4,588 applications for Fellowship on file January 1, 1932. Seven hundred and seventeen of them were already approved by their State or Provincial Committees on Credentials; 1,786 were presented to State and Provincial Committees on Credentials during this year. Of these only 811, or 45.5 per cent, were approved and recommended for examination. Of the total recommended for Fellowship before and since January 1, 1932 (1,528) our careful sifting process has admitted to Fellowship only 633, or 41.3 per cent, constituting the candidates who are here present.

Surely if we pay tribute where tribute is due we must pay full portion to the magnificent group which is before us this evening. Veritably they are the survival of the fittest.

They are to be congratulated; and the *College* is to be congratulated; but above all, we must congratulate the people who shall in the future seek their services.

Mr. President: Inasmuch as the candidates herewith presented have fulfilled all of the requirements for admission and have affirmed the Fellowship Pledge of the American College of Surgeons, on authority of the Board of Regents of the College, I take great pleasure in presenting them for Fellowship.

CASE HISTORY HONOR LIST AND PRIZE AWARD

ALLEN B. KANAVEL, M.D., F.A.C.S., CHICAGO

MEDICINE has progressed through the careful study of clinical symptoms and imaginative experiment. Hippocrates, as far as we know, was the first to make comprehensive reports of his clinical studies. One may today diagnose the pathological lesions of the ancient Egyptians by study of the reports of physicians recorded in the papyri recovered from the tombs of the Pharaohs. Paré, Potts, Hunter, Cooper, Sydenham, and a host of others have engraved their names in the history of medicine through the careful analysis of symptoms and the adequate record of their clinical studies. SURGERY, GYNECOLOGY AND OBSTETRICS was founded with the ideal of advancing the science of surgery by all practical means. The members of its Editorial Board are so heartily in sympathy with the program of the College and its demands that all patients should receive careful study, as evidenced by adequate records, that in 1930 they asked of the Board of Regents the privilege of presenting an annual prize in the form of a life Fellowship in the American College of Surgeons for the most acceptable set of case records presented by the candidates during the preceding year. The prize consists of five hundred dollars, invested in the name of the successful candidate for life dues in the American College of Surgeons, and is accompanied by an appropriately engraved certificate of appreciation on behalf of the donor, SURGERY, GYNECOLOGY AND OBSTETRICS. The prize winner last year was Dr. H. H. Ogilvie, of San Antonio, Texas.

In seeking the prize winner from among the successful candidates before you, the committee has selected 45 sets of outstanding records. An analysis of the selected group discloses the fact that they come from every part of the United States and one from Porto Rico. While New York, Boston, Chicago, New Orleans, and St. Louis appear among the larger cities represented, the greater proportion come from moderate sized or small cities throughout the country, thus demonstrating the widespread interest of the members of the College in careful case studies and records. From this group of 45, 5 sets have been selected as being outstanding, and the authors of these records have been placed upon an honor list. May I ask each honor man to rise as his name is read?

Charles B. Puestow, Chicago, Illinois
Reginald M. Norris, Jacksonville, Illinois
Leo M. Davidoff, New York, New York
William W. McGregor, Detroit, Michigan
Clyde H. Frederickson, Great Falls, Montana

And now, may I announce the prize winner from among this group and invite him to the platform to receive the certificate of appreciation from our official journal, and the formal receipt for life dues in the American College of Surgeons.

Will Dr. Frederickson please come to the platform?

Dr. Frederickson, this recognition of your work is an expression by the College of its belief that scientific investigation, careful records, and critical analysis of case histories elevates the standard of surgery and insures to patients the most efficient care. It is our hope that this expression of commendation may serve to stimulate others to emulate your example, advance the frontiers of surgical knowledge, and benefit those entrusted to our care. I congratulate you.

THE AMERICAN COLLEGE OF SURGEONS—TWENTY YEARS OF AMBITIOUS EFFORT[1]

J. BENTLEY SQUIER, M.D., F.A.C.S., NEW YORK

IT has become almost a ritual of the Convocations of the American College of Surgeons for its president to direct his remarks to the incoming Fellows, telling them of the work and aspirations of the institution into which they are being inducted.

If tonight, I am able to leave one enduring thought in your inner consciousness, I hope the thought may be that the College stands more for increasing in the minds of surgeons a keener appreciation of their moral responsibilities than for the development of unusual technical skill, I will feel that my words have not been in vain.

Twenty years is but a moment in the life of an institution destined to perpetuity, but even now, viewing those years in retrospect, I believe that adherence of the College to this concept has been the most determining factor in its progress. In the last quarter of the 19th century, leaders in the American medical profession became cognizant that if American medicine were ever to occupy a place in the sun of world approval, superhuman efforts must be forthcoming to elevate the standards of medical education.

In Europe medical education was under the domination of the Universities, while in America it was dominated by a few strong personalities and University control was lacking. Innumerable medical schools had sprung into existence with an inverted standard between numbers and excellence. A comparative few of our medical students could afford to spend the time or money to visit and study in the clinics of the old world.

It was a period, however, when the people of the United States were forging ahead in the acquisition of wealth and with it, came the desire for the best. This they were determined to obtain if they could but be shown the way. Those who had amassed fortunes were eager to use their wealth for the furthering of educational and humanitarian enterprises.

Great changes in medical thought have been influenced by the progressing intelligence of the people of the time, and the latter years of the 19th century brought great changes in medical thought, inspired largely by the changing attitude of the public toward medicine.

The public was demanding better medicine and it was for the profession to supply it. This demand of the public seems to be an expression of the idea in a great democracy, that one is entitled to a chance at the hands of the society into which he has been born—an opportunity to develop his own native talents and abilities in whatsoever direction he is best fitted; the duty of society being to make such an opportunity available.

The idea of the right to a chance started with the first settlers in this country. They had already broken from the church and from thirteenth century forms of government, and the spirit of self-determination had been awakened. When they came to this side they tried to carry on with great idealistic hope, and out of the struggle developed this ideal of the right to a chance. An ideal which will outlive any form of government now in existence.

Society considers itself to be on a humanitarian basis, but underlying this must be the consciousness that as no individual can predetermine his birth, once born, ways and means should be provided to allow him to become a useful member of society. This does not imply that the world owes him a living, but it does imply that he should have an equal chance with others for making one. Therefore, theoretically, those born into society should have their origin insured by healthy parentage, their birth safe-guarded against accident, their bodies kept free from disease, or if disease intervenes, then the best medical care at their disposal to restore them to a life of usefulness. This throws tremendous responsibility on the medical profession for it becomes the backbone of society.

It was during the eighteen-fifties, sixties, and seventies that the discoveries of the Germans, French, and English were making a science of the art of medicine. It was not, however, until the eighties and nineties that the American medical profession began to exert an influence on medical advance.

The personalities of men like Osler, Welch, Kelly, and Halstead had excited the profession to an era of scientific enthusiasm and small groups of physicians were visiting a few hospitals and clinics to observe at close range one another's work. Some of them made pilgrimages to foreign lands to witness the methods of famous medical and surgical teachers.

At the beginning of the present century the foremost group was the Society of Clinical Surgery. While a guest of this society at one of its

[1]Presidential Address, presented before the Convocation of the American College of Surgeons, St. Louis, Missouri, October 21, 1932.

meetings, Dr. Franklin Martin became so impressed by the type of clinical teaching which was being given that it awakened in him a desire to place such teaching before all American surgeons. It was the right of a chance for the many to have opportunity comparable to that of the favored few. His creation of The Clinical Congress of Surgeons of North America was the first step toward the consummation of this desire. This society had its first meeting in 1910 and received the support of many noted surgeons and teachers of surgery.

However, after the second meeting, Dr. Martin realized that the scope of this society was much too limited to encompass his more ambitious plans for improving American surgery. Such, doubtless, was his frame of mind when, on a November day in 1912, he boarded the 20th Century train at Chicago. He was on his way to direct the third meeting of the Congress to be held in New York. As the train rushed on, with the passing of each milestone, new ideas presented themselves and his ambitious plans assumed concrete form.

Calling the train stenographer, he then and there dictated the ideals, the goals of ambition, and the plan or organization for a society more comprehensive in its aims—The American College of Surgeons. When the train pulled into New York, to him the College was already a living thing.

Abraham Lincoln, while on a train to Gettysburg to honor its hallowed ground, wrote a short appeal for renewed consecration of the people's lives to the cause of freedom. His inspired words ever remain a clarion call for devotion to democracy.

Franklin Martin, while on a train, in five short paragraphs had written a clarion call to American surgeons to consecrate their lives for devotion to surgical idealism.

On the last day of the Congress, November 15, 1912, Dr. Martin presented his resolutions for the foundation of the American College of Surgeons to over two thousand men who were attending the Clinical Congress. These resolutions read—there was silence—the audience pondered—could so small a group of surgeons influence and enlist a sufficient number of other surgeons to carry to successful conclusion such an ambitious undertaking?

Dr. John B. Murphy seconded Dr. Martin's plan, and then Dr. Edward Martin, of Philadelphia, the president of the Congress, made one of his eloquent incisive appeals for the establishment of the College, but warned against any action which might give the impression to others that the contemplated project was of vainglorious conception.

The resolution was passed by overwhelming endorsement.

A Committee of Organization of twelve was appointed, and the names of those men insured success for the College from its very beginning. Their lives had been devoted to furthering surgical idealism, and their integrity of character had won the full confidence of the profession as well as of the laity.

Those appointed to the Committee of Organization were:

Edward Martin	Emmett Rixford
John B. Murphy	Rudolph Matas
Albert J. Ochsner	Charles H. Mayo
Frederick J. Cotton	George Emerson Brewer
John M. T. Finney	Walter W. Chipman
George W. Crile and	Franklin H. Martin

These names should be graven deep in the hearts of all Fellows of the College, as they are graven deep in the hearts of those who have been so fortunate as to enjoy their friendships.

This committee in its work of organization was not hampered by tradition. Tradition was in the making. Ten days following ratification of the proposal for the establishment of the College, the Secretary of the State of Illinois, on November 25, 1912, certified that the College was a legally organized corporation under the laws of that state. The first Convocation took place on the evening of November 13, 1913, at the Congress Hotel in Chicago. Dr. John M. T. Finney was elected the first president of the College.

It was an encouraging incident at this first meeting to receive greeting and wishes for success from the Royal College of Surgeons of England. These were extended by its president, Sir Rickman J. Godlee.

Honorary Fellowship in our College having been conferred upon him, he then delivered the Fellowship address. In relating the motives which actuated the formation of the Royal College of Surgeons, Sir Rickman stressed that it was an attempt by British surgeons of over one hundred years ago finally to rid themselves of any remaining taint of the Barber's Guild of the Dark Ages or of the Company of Barber-Surgeons of the sixteenth and seventeenth centuries.

The academic atmosphere of the Royal College was of later development, and eventually it became the determining body for licensing British surgeons. The precise motives which initiated the formation of the Royal College of Surgeons

were quite dissimilar to those of the American College, but the great desire to improve surgery was the ambition of both.

Nineteen years have passed since that first convocation. They have been years full of effort and mounting activities until now, it is difficult to decide which have been most productive of result. The results obtained by the Committee on Hospital Standardization will perhaps always rank among its great achievements. The circumstance which brought about the formation of this committee, and the decision to make a survey of the hospitals of the country, are full of interest and I will devote a few remarks to their consideration.

The Founders of the College had not been subjected to examination as to their surgical capacity, but by the time of the second convocation over two thousand applications for Fellowship had been received and the Regents appreciated that examination for admission to Fellowship must be instituted.

It was obvious that before admission, each applicant for Fellowship should possess an adequate background of surgical experience. Equally important, however, was for him to have strength of character to withstand absolutely every temptation to commercialize his calling. It was decided that a fair estimate of an applicant's surgical experience could be made by a careful examination of submitted case records of his personal work.

The estimation of his character must be left to his intimate associates, and for this the College would have to rely upon the judgment of his local confréres. A Central Committee on Credentials was appointed to pass upon the excellence of submitted records, with a local committee to pass upon the character and general fitness of any applicant. The examination of the submitted records, in many instances revealed a woeful lack of understanding of what really constituted a good case record, and many candidates reported that in the hospitals with which they were connected, no case records were even kept.

If this was the situation in many hospitals, what also were their surgical standards, what measures were being taken toward proper education of their internes, and divers other questions must be answered. To obtain this information an intimate survey of the hospitals of the country became imperative.

The Regents, however, believed that such an investigation should be undertaken by the American Medical Association as it represented the medical profession as a whole.

Since 1910, the American Medical Association had been interested in classifying medical schools and analyzing the results of examination of their graduates before state medical boards, and possibly on this account, were not interested in taking up another investigation at this time. Nevertheless, the College determined to undertake the survey, even though such an investigation presented many obstacles.

By what measures could the lay and medical boards of the hospitals of the country be induced to permit their institutions being investigated, classified, and standardized by the American College of Surgeons?

What presumption of a very young organization to consider that it was qualified to pass judgment on the efficiency of institutions possessing traditions of excellence which many of them held! To combat this opposition, the hospital authorities were informed that the contemplated investigations were instigated by a desire on the part of the College to be of valuable service to them; to demonstrate how to make their hospitals of better service to the patients, to the community, and a more advantageous workshop for their professional staff. To outline the standard of service they should demand of their medical staff, how to evaluate such service and the standard of ethics their staff should possess.

As this work progressed, those in charge were continually being consulted by heads of hospitals from all over the world as how to increase the efficiency of their institutions.

Today there is scarcely a hospital in our country whose personnel fails to be filled with pride to have their institution included in the ranking group of those which have been investigated. The initiation of this work required all the tact, patience, and perseverance that the College could muster. The carrying on of the work to a successful issue took years of painstaking labor on the part of the officers of the College and those associated with them in this special undertaking.

If the American College of Surgeons in the twenty years since its incorporation had accomplished nothing else than the improvement which it has produced in raising the standard of American hospitals, this work alone would have more than justified its birth.

Standardization of hospitals was commenced during the period when Dr. John G. Bowman was one of its officers. It was at this time that the Regents drafted the first tentative outline of the minimum standard for hospitals. Our Director General in commenting upon this outline in his report delivered at the annual meeting in 1924 said: "This document has now achieved international fame and has become to hospital better-

ment what the Sermon on the Mount is to a great religion."

Dr. Bowman had exerted a unique influence on the College, for having had a scholastic and not a medical training, he viewed our problems in a more detached manner than could a man of medical mind. An idealist himself, he appreciated idealism in others and was able to expound the doctrine of surgical idealism with inspiring conviction. Dr. Bowman was called to become Chancellor of the University of Pittsburgh.

The standardization of hospitals was a project which required considerable expenditure of money, the raising of the endowment fund to meet this, and the other increasing expenses of the College was a most creditable accomplishment in these early years. The Fellows at once responded to the call for funds, and by the time of the third convocation the sum of over two hundred and fifty thousand dollars had been pledged.

The fund has grown year by year until now it is well over one million dollars. It has been well invested and the income derived from it judiciously expended. The financial sagacity of those Fellows who have guarded this and all other funds of the College deserves commendation. An examination of the securities held by the College at this period of financial deflation, produces admiration for the judgment of these men.

This spirit of the Fellows to give of their own, without waiting for aid from philanthropical sources was the strongest demonstration of their belief in this institution. A similar spirit was exhibited, when it became expedient to determine which city—in the United States—should be chosen as the permanent home for the College. There was much discussion and the pros and cons make a long story. Finally it was decided, as such questions usually are, by the financial equation.

The Fellows of the College residing in Chicago and their friends raised the money, purchased a site in Chicago, and gave it to the College. A few years later, Chicago again made the College its debtor by presenting a building, a monument to one of America's greatest surgeons, Dr. John B. Murphy. There is a peculiarly significant sentiment in the principal College building being a memorial to him, for you will recall that it was Dr. Murphy who seconded Dr. Martin's resolution for the foundation of the American College of Surgeons. It was to him, Dr. Martin had first confided his ambitious project, and it was from him that Dr. Martin had received the most sympathetic encouragement.

Next year the College will meet in Chicago, and you Fellows will have opportunity to view its home. If you start from Wabash Avenue and walk East on the north side of Erie street, you will pass first, the Administration Building of the College (a gift from Chicago Fellows), then the Murphy Memorial Hall (a gift from the family and admirers of Dr. Murphy), and last, what is to be the greatest gift of all—54 East Erie Street and its contents—the journal of SURGERY, GYNECOLOGY AND OBSTETRICS (to be a gift from Dr. and Mrs. Franklin H. Martin). Pause a moment on the corner of Rush Street and consider how greatly the Journal has aided the College. Before the College was ever contemplated, this journal was already a publication of international importance. Later carrying our propaganda it helped us to win respect of the surgical world for the ideals of the American College of Surgeons.

The journal will become the most determining gift for success. The north side of Erie Street represents fulfillment. With this thought in mind, cross to the south side and walk back. The first half of the block was bought by the College in 1928—and imagination visualizes a future building to house the library and museum; the second half of the block is now under consideration for developments in the future. The south side of Erie Street represents hopes deferred, but long before another twenty years have elapsed these too will be fulfilled.

In 1916, the College activities became subservient to medical preparedness as war clouds were gathering and all efforts were extended to be in readiness if war was declared. The Secretary General of the College was appointed by our government to be the chairman of the Medical Board of the Council of National Defense. This appointment brought grave responsibilities to him and the manner in which he met them will ever be a source of great pride to this organization.

The Fellows responded nobly to the call for enlistment in the Reserve Corps of the Army and Navy. Dr. Crile, who was then president of the College, had his Lakeside Hospital Unit mobilized in Philadelphia where the College met that year. It was an object lesson. When war was declared over 90 per cent of the Fellows were in uniform and those not in uniform were in some governmental service. However, what was true of the Fellows of the College was equally true of the whole medical profession of the United States. Never in history has the medical profession ever failed to respond to the call of duty. The World War brought our surgeons and medical men in close contact with those of our Allies. Working shoulder to shoulder with them under tragic circumstances produced mutual respect and regard.

Two episodes in the history of the College may bear retelling, even though many of you may be familiar with them.

The year following Sir Rickman Godlee's visit to the first Convocation, the College received a gift of a gavel from him, and upon it was inscribed: "This mallet was devised and used by Lord Lister, and is presented to the American College of Surgeons by Sir Rickman J. Godlee, then president Royal College of Surgeons England, in memory of his visit to Chicago, November 1913."

This, indeed, was a gracious gesture. Lord Lister was an uncle of Sir Rickman and with this gift a priceless family heirloom came into the possession of the College.

The second episode occurred after the war, when the surgeons of the British armies presented the Great Mace with the following inscription: "From the Consulting Surgeons of the British Armies to the American College of Surgeons, in memory of mutual work and good fellowship in the Great War 1914–1918."

The war over, the activities of the College grew apace. The acquiring of the College library and the establishment of a Department of Literary Research and the service which that department has rendered to the Fellows of the College is an engrossing tale.

In an attempt to extend clinical teaching, the College in 1919 arranged for sectional meetings so that smaller groups of the Fellows could discuss questions and receive instructions from well known leaders in surgery.

These sectional meetings included one evening set apart when the laity were invited to attend. They would be addressed by local professional men and officers of the College. The subjects presented were medical ones of popular interest. The lay public were to be admitted to professional confidence. Opposition to this innovation by more conservative Fellows was acute; however, as it has ever been the policy of the College properly to instruct the public in medical matters, the innovation succeeded. Today these sectional meetings are among the most favored of the College activities. We have taken the public into our confidence and by so doing have gained theirs. This we must never lose. The belief of the College that the public should be kept informed concerning medical advances is only a reflection of the present world point of view. Medicine has long since ceased to be a mystery in the minds of educated people. It is our duty to them to help make medical truths understandable, to keep them from being duped by false statements of impossible cures and in every way indicate that the College was formed for their interest as well as for the profession.

The Department of Clinical Research has expanded its work until now it requires two Boards and five Committees to take care of it.

The Board on Industrial Medicine and Traumatic Surgery has already accomplished much. Industrial medicine is passing through deep waters, with the problem of compensation practice.

If this Board can exert its influence toward a solution, the College will have performed another great public service. Compensation practice is inherently different from regular practice. The relation of the physician to the patient is not a natural one. I shall not go into the many disagreeable features. Compensation practice in many localities has fallen into such bad favor that many physicians do not, as a general rule, desire to undertake it, thus producing a tendency for concentration into the hands of the unscrupulous. One way in which the situation might be corrected, would be to take this type of practice out of the hands of individuals and place it in the clinics of the reputable hospitals of the country. I am aware, that there are objections to this, but the point requiring most emphasis, in advocating the establishment of industrial clinics in our reputable hospitals, is that such a step could in no wise be interpreted as furthering State medicine. Those clinics would have to be especially organized to handle industrial accidents. Their expenses would be paid for by insurance companies. Being paid clinics they would provide part time positions for a great number of young surgeons. In this way, compensation practice would be widely distributed among young medical men of high caliber. In addition, these clinics would provide a tremendous amount of material for statistical and research purposes. Comparative methods of treatment could be followed intelligently and results statistically analyzed, so that much might be learned as to how to obtain the best results at the lowest cost in the shortest possible time. This is a particularly good moment to interest hospitals in this project. Many are financially embarrassed, and industrial clinics would be a sure source of considerable revenue. I have talked at some length about this subject because in many of the larger cities the abuses have approached a racketeering stage.

I would, time permitted, acquaint you men who tonight are being admitted to Fellowship, with all the interests which the College has undertaken, but the few I have mentioned may give you some idea of the scope of its many activities.

I would, time permitted, pay personal tribute to each one of the officers and regents, who in the years gone by have sacrificed their time and given of themselves to further the interest of the College.

Often while reflecting on the College, the thought has come to me, that with Finney of Baltimore, Crile of Cleveland, the Mayos of Rochester, Armstrong and Chipman of Montreal, Martin and Deaver of Philadelphia, Cushing of Boston, Ochsner and Kanavel of Chicago, Matas and Miller of New Orleans, Brewer and Stewart of New York, and Ireland of Washington to help him, maybe Dr. Martin did not have so difficult a task in directing the College to its present enviable position.

It has been nevertheless an unselfish service on the part of each and when his term of office expired has continued working even more assiduously for the good of the College. When I say good of the College it presupposes good for humanity and good for each Fellow of the College.

During its short life the scientific contributions of many of the Fellows of the American College of Surgeons have helped to bring world recognition to American surgery.

It has been a wonderful experience to have lived and worked during this Renaissance of Surgery, but scientific advance is an endless adventure. It is not for us to be satisfied with what has been accomplished but to look beyond.

The College with many of its ambitions already realized has as yet but indented the surface of opportunity.

This child of Franklin Martin's imagination and foresight will be of age in another year. The child has had many watching its growth and many guiding its youthful steps and you, new Fellows, will have to assume the guardianship of its advancing years. You bring new faces, new ideas, and new energy to us, and to you—we give our faith.

Remember always, that the American College of Surgeons has never an axe to grind save one, and that must ever be kept, ground to a Toledo edge, to blaze the trail through the dark wilderness of sophistry into the sunlight of scientific truth.

NEW VIEWPOINTS IN PHYSICS[1]

ROBERT A. MILLIKAN, PH.D., PASADENA, CALIFORNIA

THE past twenty years have been the most surprising and the most extraordinary in the history of science in bringing to light new phenomena completely unpredictable from the simple, rigidly mechanical conceptions of the nineteenth century, and they have taught the physicist a lesson of modesty, open mindedness, and reluctance to extend his generalizations beyond the range of his experimental verifications, such as he has not had in the past and such as some other branches of knowledge still lack. It is, therefore, useful for the other sciences and for the public to follow, as well as they can, the new experimental findings in physics so that they may avoid better than they now do and better than the physicist has done in the past *dogmatic assertiveness without knowledge*, whether it be in science, philosophy, sociology, politics, or theology. I am, therefore, passing in rapid review tonight first the growth of our ideas about the atomic nature of matter which led to the general acceptance within our century of the kinetic and atomic theories in all branches of what we called the physics of matter.

I am then passing in review the growth of our ideas from 1800 A.D. down in that other half of physics which we call the physics of the ether, until by the beginning of this century the wave theory of radiation of all sorts, from wireless waves to cosmic waves, became generally accepted. Everything worked well so long as these two fields were kept separate, but within the past two decades they have revolted completely against such separation. We have gone over into new fields of experimental studies, in which we deal not with large scale phenomena but with solated elementary processes themselves, and in these elementary processes, in which, for example, one single electron is acted upon by light waves, or X-rays, or gamma rays, we have found that ether waves—which represent in our analysis continuous processes—act not like waves but like particles. Also within the past 5 years, we have found experimentally that streams of particles, whether they be electrons or atoms, exhibit all the wave properties which we have heretofore attributed only to "radiation phenomena." In other words, the physicist has been obliged to find some way to reconcile apparently contradictory behaviors. Personally, I see no way out of the dilemma except to assume that, at bottom, the world of physical experimentation consists of particles, and to try to get wave properties, whether of atoms, electrons, or photons, out of statistical behavior of great swarms of these different sorts of particles.

Efforts are now being made, with some success, by theoretical physicists to derive such wave properties out of the statistical behavior of particles, though other theorists prefer to reverse the process and to consider the wave properties as the more fundamental. At any rate, the wholly unexpected discovery that experimentally at least all interference phenomena can be obtained from streams of flying particles, represents one of the most amazing developments in the whole history of science and should teach physicists and all mankind the lesson of the danger of extending our generalizations beyond the range of experimental verification. Modern physics has been taught by its mistakes to agree with the poet Shakespeare that there are more things in Heaven and earth than have been dreamed of in our philosophies.

[1]Abstract of Fellowship Address, presented before the Convocation of the American College of Surgeons, St. Louis, Missouri, October 21, 1932.

Robert A. Millikan

UNIV. OF MICH.

OPHTHALMOLOGY, OTOLARYNGOLOGY

SECTION ON OPHTHALMOLOGY

THIS section met in the ballroom of the Statler Hotel on the evening of Tuesday, October 18, with Carl Barck, M.D., St. Louis, presiding. Two papers, abstracts of which follow, were presented and will be published elsewhere.

HIGHWAYS AND BYWAYS IN OPHTHALMOLOGY

HANS BARKAN, M.D., San Francisco: There are a number of interesting literary, artistic, and mythological fields of knowledge into which one can dip and find the eye of interest, with often a deep speculative value in arousing one's mental processes. The eye in art has been handled differently by different painters of different centuries; the eye in statues has been represented as a blank or as composed of jewels; the eye in mythology has been given certain values, as for instance, the ox-eyed Juno, or gray-eyed Athene. Descriptions of the eyes of famous men are found in Plutarch's *Lives*. The eye diseases of famous men such as Goethe, Wagner, Carlyle, Milton, Lincoln, and others have been fully described by our American author Gould; and inferences have been drawn as to their relationship to the general individual and his work. The superstitions concerning the eye are many: the evil eye—the origin of the pennies on a dead man's eyes and the representation of a witch with cross eyes. The whole field of ophthalmology contains no more interesting subject of literary research than mention of the eye as an organ expressing love, hate, despair, tragedy, cunning, and other emotions, as often represented in Shakespeare and the Bible. In general the object of this paper has been to indicate many interesting allusions to the eye in literature, art, and superstition.

CHANGES IN OCULAR REFRACTION

EDWARD JACKSON, M.D., Denver, Colorado: Development of the refractive media of the eye is well started in the first month of fetal life, and the lens continues to grow until old age. Changes in refraction occur at any age, and are most common in childhood and after middle life. At birth almost all eyes show hyperopia, which diminishes with the normal growth of the eyeball. Myopia appears during school life and may increase, unless controlled by correcting glasses. Astigmatism may change at any age; and does, in almost all eyes in later life, from changes in the crystalline lens, whether these cause cataract or not.

Uncorrected errors of refraction are the most common and serious handicap, for the higher occupations and popular amusements, of civilized life. They are recognized by the symptoms they cause; which can only be understood and met by those who have the full medical education. The decrease of accommodation, after middle life, makes slight changes of focus more important and annoying, and changes of astigmatism are very often overlooked. The time of life, when testing for glasses is often left to the optician, is the time that the most careful and exact measurement of the focus of the eye is of special importance; and when it gives important information about the existence of degenerative changes in the eye, or other parts of the body.

SECTION ON OTOLARYNGOLOGY

AT the meeting of this section in the ballroom of the Statler Hotel on the evening of Thursday, October 20, Max A. Goldstein, M.D., St. Louis, presided. The following papers were presented: "History and Development of the Operative Treatment of Facial Palsy," by Arthur B. Duel, M.D., New York. This paper is published with illustrations in this issue. A second paper on "Suppuration of the Petrous Apex in Relationship to Meningitis" was read by Wells P. Eagleton, M.D., Newark, New Jersey, and is to be published elsewhere.

SYMPOSIUM: CANCER IS CURABLE

THE CURABILITY OF CANCER

FRANKLIN H. MARTIN, M.D., F.A.C.S., CHICAGO

MAY I cite briefly the objectives that were in my mind when this symposium on the "Curability of Cancer" was organized. Through the reports of cancer cures that will follow, it is my hope:

1. To impress upon the practitioners of scientific medicine, and indirectly upon the public, the fact that carcinoma is curable by the use of well known and established methods of treatment.

2. To point out in a convincing manner that if all cases of cancer could be diagnosed early and treated promptly in their incipiency, the annual death rate from the disease, now recorded as 150,000 in the United States and Canada, would be reduced by at least 33 per cent, or 50,000 per year. Even if only one-half of the cancer cases could be diagnosed early and properly treated, the death rate would be reduced by 25,000 per year.

3. To bring together the group of distinguished clinicians here present—an overwhelming authority—to present definite statements of the impressive number of cases of cancer that have actually been cured. This preponderance of evidence, so convincing as an object lesson, will impel ever increasing numbers of the people to demand facilities, through scientific doctors, for annual or semi-annual examinations, so that not only cancer, but any and all diseases may be discovered in their incipiency, when they are amenable to treatment.

4. To get the maximum of ethical publicity of the reports. This will furnish convincing evidence to our hospitals, our local medical societies, and our already established clinics, and encourage them to furnish facilities whereby every physician who is practicing scientific medicine will have available the necessary equipment and trained aids to insure the comprehensive examination of his patients.

5. To convince the profession and the public that even though cancer is already apparently in a later stage of its development, if it is subjected to proper treatment, its progress may often be stayed, and the disease not infrequently cured; to make these facts so obvious that a general policy will be established to treat systematically every case of cancer, in whatever stage of advance, not only because of the immediate or remote possibility of a cure, but because palliative measures would bring great encouragement and relief of distressing symptoms.

6. To establish a universal policy among physicians and surgeons of reporting cancer cures rather than to present the involved comparative statistics that dwell particularly on the cases not cured.

If we here present accomplish the full humanitarian purposes for which this symposium was organized, the discouraging psychosis that now exists in the minds of the profession as well as the public will be dispelled. A consciousness that *cancer is curable* will be established in the minds of all; fear will be displaced by a spirit of hopefulness; and every victim of cancer or suspected cancer will present himself for early diagnosis and treatment.

CANCER CURES—5 YEARS AND MORE

Reported by speakers in this symposium	4,348
Cases registered by American College of Surgeons	1,203
Cases reported in the literature, incomplete recent survey	3,089
Specially reported in this symposium	140
Total	8,840

CLASSIFICATION

Cervix	1,561	
Fundus	345	
Ovary	42	
Breast	3,634	
Bladder	233	
Prostate	43	
Kidney	125	
Testis	38	
Thyroid	165	
Larynx	50	
Mouth	867	
Stomach	356	
Skin	866	
Colon and Rectum	116	
Bone	90	8,531
Other classifications		309
Total cancer cures 5 years and over		8,840

CANCER RELIEF

WALTER C. ALVAREZ, M.D., ROCHESTER, MINNESOTA

I HOPE you will be patient with me as I do what I can to pinch-hit for a great man. I am keenly interested in this program today because I feel the need for it. In spite of the great efforts that have been made to bring patients with carcinoma to the surgeon or the radiotherapist as early as possible, thousands of these people are still waiting months or years before they present themselves. There are several causes for this dilatoriness and some are beyond our control, but one at least we must strive harder to remove and this is the hopeless, apathetic, or uninterested attitude of some of the physicians who first see the patients. Some of these doctors seem actually to be doubtful if cancer is ever cured.

So many of you are going to tell us of the splendid results that can be obtained in many cases of cancer that I am not going to say a word about this phase of the subject. The only point I would like to make is that more effort must be made to reach the general practitioner with brief summaries of what can be done in the way of curing cancer in the several parts of the body. For instance, we must admit that cancer of the œsophagus is hopeless but, when taken early, cancer of the breast or colon or cervix is anything but hopeless. In the past, too much of this information has been published in special journals which are never seen by the general practitioner.

The physician must be taught, also, that even when, in a given case, the disease looks incurable there is always a gambler's chance that with removal of the main growth health will return and metastatic growths will lie dormant for several years. A 5 year cure is wonderful but so also is a 2 year or a 3 year cure.

Finally, the profession must be encouraged to take better care of the forgotten man: the patient with inoperable carcinoma. Most of us physicians hate to see these poor people. We feel uncomfortable when talking to a man who has just been condemned to death; we hate to see the suffering in the faces of his relatives; we don't know what to do with him, and as a result, too often we say as little as possible; we urge him to go home, and we abandon him to the rapaciousness of the quack who lies waiting for him around the corner.

This is not right; we must not shirk our responsibilities in this way, and besides, in most cases there is much that we can do to add to the comfort of these patients. Often it pays to remove or clean up the main growth. We may perhaps short-circuit an obstructing tumor in stomach or colon and thus give many months of good health. We can often clean up foul discharges, and sometimes we can stop fiendish pain with a dose of roentgen rays. Occasionally, to our astonishment, irradiation will even work a cure when none was expected.

We can do much to keep up the morale of the patient and his family; it is terrible to have to sit by idly and watch a loved one die, and the kindliest thing we can do for many of these families is to keep them busy doing something; if we don't they are almost certain to fall into the hands of quacks and scoundrels.

Too often we do not even make a fight to see that the patient has enough morphine to relieve his pain, and we do not always see to it that he has harmless sedatives so that he can sleep at night. (We now have the new drug Dilaudid which can be taken by mouth; it relieves pain much as morphine does, and it probably is not habit-forming).

In some cases we can raise the patient's resistance to the growth of the carcinoma with the help of a richer diet, injections of foreign protein, and transfusions of blood. There is no question that some persons have an enormous hereditary resistance to the development of cancer, and this resistance should be conserved.

In some cases it is worth while to try injections of lead, and I am hopeful that something will come of the experiments in which the whole body is being irradiated over a period of time. I would be willing to let a patient try anything that is not definitely injurious.

Unfortunately many physicians will hesitate to treat incurable cancer with any degree of hope and optimism for fear of being criticized by their colleagues. They will fear the accusation that they are treating the patient merely for the money that is to be made. This fear of blame would be largely removed if a great medical organization like this College were to approve officially of and advocate more palliative treatment.

It is reported in an ancient manuscript that Christ once on the Sabbath day saw a man working hard to shore up the foundations of a poor widow's house being undermined by a swollen stream. He said to him, "Man, if thou knowest what thou art doing, blessed art thou, but if thou

TABLE I.—SUMMARY OF SALIENT RESULTS OF TREATMENT OF CARCINOMA AT THE MAYO CLINIC*

Organ involved		Percentage of patients living†	
		3 years later	5 years or more later
Stomach	795 patients traced following resection		24
Colon and rectum	602 patients traced following resection	47	33
Fundus of uterus	Lesions suitable for excision alone Lesions suitable for excision and irradiation Inoperable lesions treated by irradiation	 37 26	53 31 13
Cervix of uterus	1001 patients traced Operable Borderline Inoperable Modified by previous treatment		 75 62 21 25
Breast	1859 patients operated on Without lymphatic involvement With lymphatic involvement	 80 42	 67 20
Kidney	256 patients operated on; some irradiated also		43
Bladder	600 patients treated by surgery and irradiation		28
Prostate gland	900 patients traced 164 cases of prostatectomy		 13
Œsophagus	228 patients traced; all died		
Thyroid gland	204 patients operated on 87 patients traced following operations and irradiation 71 patients traced after irradiation alone	38	 71 24
Face	250 cases Without involvement of cartilage or bone With involvement of cartilage or bone		 93 78
Eyelids	251 cases		43
Outer ear	56 patients treated	47	20
Antrum of Highmore	27 patients with tumor primary in maxilla 70 patients with tumor primary in antrum		30 16
Mouth	Surgical removal early Irradiation alone		35 15
Pharynx and base of tongue	89 patients traced	16	
Larynx	86 patients traced Carcinoma graded 2 Carcinoma graded 3 Carcinoma graded 4, all dead	 71 05	
Lung	42 patients treated by irradiation; life prolonged		
Gall bladder	30 cases studied		3
Appendix	37 patients traced; no deaths from carcinoma		

*It must be remembered that the figures given here represent results obtained only in cases in which the disease could be attacked with a small probability of success.
†Of patients traced.

knowest not what thou art doing cursed art thou!" If we physicians can bring ourselves to help these poor patients because of our pity for them and our feelings of consecration to our work, I am sure we will be blessed.

In some cases of course the wise and kindly physician will advise against costly treatments if he thinks that they are quite hopeless and if the patient is so poor that he must try to leave everything possible to his wife and children.

Let us then go forward with a clearer knowledge of the type of case in which we most certainly can cure cancer, as well as with a greater feeling of responsibility toward the many poor sufferers whom we now turn away with barely a word of advice.

IS CANCER CURABLE?

J. M. WAINWRIGHT, M.D., F.A.C.S., SCRANTON, PENNSYLVANIA

IT is the experience of everyone whose lot has led them to special interest in cancer surgery frequently to be asked, "Do you ever cure a cancer?" Many times the question comes from those who should know better.

Other papers in this group will deal with results in large series of cases. This paper will not consider statistics or percentage results but will relate in brief a few cases which give somewhat striking proof that we do cure cancer.

THE BREAST

1. Miss C. G., was operated on at the age of 61 on October 13, 1903. Her tumor had been noticed 6 years before. It was large. The microscopic examination was unquestionable and it showed infiltration of pectoralis major muscle fibers. This was the writer's second breast operation and it was not one to be proud of. This old lady was carefully followed. She remained well and active. The photograph shows her in August, 1928, at the age of 85 still in the active direction of her farm. In January, 1930, she was found dead in bed at the age of 87, 26 years and 3 months after operation. She had been examined a few months before and found apparently cancer free and with no special complaints (Fig. 1).

2. A doctor's mother, aged 49, was operated on on January 20, 1910. She had had her tumor for 1 year. The microscopic examination was unquestionable and the axillary glands were involved. This lady at this writing is in good health, aged 71 and cancer free, 22 years and 9 months later.

3. Another patient is well and cancer free at the age of 66 years, 20 years after operation.

MELANOMATA, WITH METASTASES

(than which few things are more malignant)

1. S. S. Operated on August 25, 1905, aged 36. Four months before he had noticed a black tumor over the right scapula. Two months later he noticed a mass in the axilla. Within the next few months metastatic tumors were removed from the left shoulder and the opposite axilla. He had four operations in all, the last January 6, 1906. Microscopic examination unquestionable. This man is under close observation and is well and cancer free at this writing, 27 years and 2 months after the first operation.

2. H. L., was operated on on January 7, 1915. He had a rough pigmented mole on the right arm which a few months before metastasized to the glands in the neck. The mole and the glands were removed. The microscopic examination was unquestionable. This man is under close observation. Last examined July, 1932, at which time he was well, cancer free, and working regularly in the coal mines 17 years and 6 months after operation.

3. Mrs. A. C., operated on on August 23, 1912, aged 62. She had a melanotic patch under the right thumb nail. Six months previously it metastasized to the right axilla. Amputation of the thumb and removal of a mass the "size of a baseball" from the axilla. This patient kept under close observation and remained cancer free and did hard farm work in the fields. She died suddenly of apoplexy, aged 77, 15 years after operation.

THE LIP

1. E. H., operated on on April 21, 1904, aged 45 years, for cancer of the lip. Section was unquestionable. Twice within the next few months the involved glands were removed from the neck. She was kept under close observation and remained well and cancer free. She was killed in an accident 23 years and 6 months after operation, aged 68.

THE UTERUS

1. Mrs. M. B., aged 29 years. Treated by radium July 1, 1920. She was in a very distressing stage of emaciation and cachexia. The entire vaginal vault was filled with a large cauliflower-like mass and a mass could be felt above the pubes "as big as a grapefruit." Why I treated her with radium I do not know. It was in my early experience with radium and I knew no better. She was discharged a few weeks later still in very poor condition and her death within a few weeks seemed certain. For several months no notice whatever was taken of follow-up letters and finally a medical friend in her town was requested to visit the family "to get for our record the date of death." He replied, "not dead. I found her in the yard hanging up the washing." This woman has remained well and 12 years after treatment in July, 1932, she was examined and found cancer free. She was well nourished and doing the usual hard work of a foreign woman, the wife of a miner.

These cases surely determine the q. e. d. to the claim that we do cure cancer. Furthermore, these cases represent the work of 20, sometimes nearly 30, years ago. Hundreds of other surgeons were curing cancer at this time and long before as a small army of patients can attest.

Fig. 1. Miss C. G. taken on her farm at the age of 85 years, 24 years after operation for breast cancer.

Of more hopeful value still is the fact that since the patients of 20 years ago were operated on, technical surgery has greatly advanced in its own field and more important still, there has been added the great advantage of radium, improved roentgen technique and equipment, and the electro-knife. In some cases radiation alone has become more efficient than surgery. In most cases it is an indispensable adjunct.

Many surgeons who were producing permanent cures in the first decade of this century are still working with vastly increased experience and skill. Younger men much better trained than the older men when they began are constantly entering the lists and with the physical aids just noted the number of permanent cures in the present decade will be many times greater than for the period of 20 years ago.

END-RESULTS OF RADIUM THERAPY IN 475 CASES OF CERVICAL CANCER

FLOYD E. KEENE, M.D., F.A.C.S., PHILADELPHIA

FROM 1913 to July, 1926, 475 cases of carcinoma of the cervix were treated with radium in the John G. Clark Clinic of the Hospital of the University of Pennsylvania. More than four-fifths of the patients presented advanced malignancy and in only about 12 per cent could the lesion be classified as belonging to Stage I.

During the period covering the early years of this report, the routine treatment consisted of 2,400 milligram hours of radium filtered by 1 millimeter of silver or 2 millimeters of brass and 2 millimeters of soft rubber tubing, with repetition of the irradiation at the end of 6 weeks. During the later years the second application was omitted, re-radiation being employed only when evidence of continued growth was found. Deep X-ray therapy supplemented radium in only 5 patients. The results show that re-radiation was of palliative value but it did not increase the percentage of ultimate cures.

Complete follow-up data are available in over 89 per cent of the entire series and patients not traced are classified as dead from cancer. Seventy-three patients were free from any evidence of malignancy 5 years or more after the initial treatment which represents a total salvage of 15.24 per cent. In justice to radium treatment, however, it should be stated that during the earlier years included in this report hysterectomy was performed when the lesion was operable and only the advanced cases were subjected to radium. From 1920 to 1926, both the early and the late lesions received radium treatment and in the group belonging to these years the total salvage was 18.28 per cent. Ninety-two cases are classified as belonging to Stages I and II. Thirty of these, or 32.60 per cent, showed no evidence of disease 5 years or more after treatment was given. The lesions were more extensive in 383; of these, a salvage of 5 years or more was obtained in 43 or 11.22 per cent.

In the 58 patients whose lesions were classified as Stage I, either radium alone or cautery amputation plus radium was used with a cure rate of 39.65 per cent; the best results followed cautery amputation and irradiation, for in 34 patients thus treated 18, or 52.94 per cent, were free from evidence of malignancy more than 5 years after the initial treatment.

Specimens from 168 patients have been graded according to the classification of Martzloff. The striking feature of this analysis is the low curability rate (13.05 per cent) in the spindle cell type which is recognized as being highly radiosensitive. The best results, 26.66 per cent, were obtained in the transitional cell group. In the adenocarcinomata and the epidermoid types, the results are practically the same (17.85 per cent). It would seem, therefore, from these findings that prognostically, grading according to cell type is not of much practical value.

Dissatisfied with our results, we have entirely reorganized our methods of attack during the past year. This modification consists not only in the technique of radium application, but the addition of routine roentgen therapy and the adoption of a plan whereby the problem as a whole can be more efficiently handled.

END-RESULTS OF THE TREATMENT OF MALIGNANT DISEASES AT THE CLEVELAND CLINIC

GEORGE CRILE, M.D., F.A.C.S., CLEVELAND, OHIO

MY associates, Dr. W. E. Lower, Dr. T. E. Jones, Dr. U. V. Portmann, Dr. R. S. Dinsmore, Dr. W. V. Mullin, and I have seen 8,679 cases of malignant tumors of the various organs and tissues of the body. Of these, 2,756 were treated by operation only, 1,399 by operation and radiation and 1,931 by radiation only, and 2,593 were not suitable for treatment. Four thousand and fifty-nine of the patients seen prior to 1928 have been traced. Of these, 1,182 have survived for 3 years or more and 737 for 5 years or more.

Our series includes 786 cases of cancer of the skin and subcutaneous tissues. Of these, 262 were treated by operation only, 75 by operation and radiation, and 360 by radiation only. Among the 215 patients seen before 1928, 100 have survived for 3 years and 52 for 5 years.

We have seen 618 cases of cancer of the buccal surfaces and jaws of which 300 seen before 1928 have been traced. Among these, 94 patients have survived for 3 years and 53 for 5 years. In this series, 220 patients were treated by operation alone, 165 by operation and radiation, and 174 by radiation only.

Of 162 cases of cancer of the larynx, 47 were treated by operation only, 31 by operation and radiation, 28 by radiation alone. Fourteen patients have survived for 3 years and 9 for 5 years.

Of 292 cases of malignant diseases of the thyroid gland, 79 were treated by operation alone, 131 by operation and radiation, 44 by radiation only. One hundred and eighty-five of these patients have been traced. Of these, 55 have survived for 3 years or more and 37 for 5 years.

Of our total of 1,555 cases of cancer of the breast, 919 of those seen prior to 1928 have been traced. Of this series, 437 patients have lived for 3 years and 307 for 5 years. In this series, 860 patients were treated by operation only, 500 by operation and radiation, and 57 by radiation only.

We have seen 2,264 cases of malignant tumors of the gastro-intestinal tract and other abdominal tumors which include 140 cases of tumors of the œsophagus, 726 of the stomach, 69 of the gall-bladder and ducts, and 841 of the large intestine and rectum.

Thirteen patients with carcinoma of the stomach have survived for 3 years and 7 for 5 years. Eighty-nine patients with malignant tumors of the large intestine and rectum have survived for 3 years and 48 for 5 years. In the latter series, 246 were treated by operation only, 78 by operation and radiation, and 142 by radiation only.

We have seen 553 cases of malignant tumors of the urinary tract, 143 of the kidney, 389 of the bladder, 18 of the urethra, and 3 of the ureters. Of the patients with tumors of the kidney, 16 have survived for 3 years and 7 for 5 years. Of the patients with malignant tumors of the bladder, 150 were treated by operation only, 45 by operation and radiation, and 93 by radiation alone. Of these, 47 have survived for 3 years, and 30 for 5 years.

Our series includes 464 cases of malignant disease of the male reproductive organs, including 336 cases of tumors of the prostate gland. Of the patients in the latter group, 72 were treated by operation only, 19 by operation and radiation, and 121 by radiation only; 24 patients have lived for 3 years and 9 for 5 years or more.

We have seen 1,171 cases of malignant diseases of the female reproductive organs including 676 of the cervix and 246 of the fundus. Of the cases of cancer of the cervix, 121 were treated by surgery alone, 34 by surgery and radiation, and 357 by radiation alone; while of the cases of cancer of the fundus, 123 were treated by operation alone, 24 by operation and radiation, and 63 by radiation alone. Of the patients in this total series, 159 have lived for 3 years, 98 for 5 years.

Exclusive of carcinoma of the jaw, we have seen 176 cases of malignant disease of bone. Forty-four of these were treated by surgery alone, 31 by surgery and radiation, and 51 by radiation alone. Fifteen have survived for 3 years and 10 for 5 years.

REPORT ON FIFTY CASES OF FIVE YEAR CANCER CURES

DONALD GUTHRIE, M.D., F.A.C.S., SAYRE, PENNSYLVANIA

I WISH to report briefly upon 50 cases of 5 year cancer cures, taken at random from our files, the present conditions of which have been carefully investigated in a follow-up clinic and found to be satisfactory.

1. Twenty-five breast cases, 8 showing axillary involvement at the time of operation. Of these 8, 2 are well 5 years; 1 well 6 years; 2 well 7 years; 2 well 8 years; and 1 well 16 years.

2. Eight cases of cancer of the cervix. One treated by panhysterectomy is well 7 years. Of 6 cases upon whom radium alone was used, 3 cases are well 7 years and 3 cases well 8 years; dosage 2,400 to 5,500 milligram hours.

3. One case of cancer of the vaginal wall wore a pessary 8 years without removing it. She has been well 12 years and had 1 dose of radium 1,500 milligram hours.

4. Five cases of cancer of the body of the uterus. Of 4 treated by panhysterectomy 1 is well 5 years; 2 are well 6 years; and 1 is well 7 years. One treated by radium is well 8 years and had 4,800 milligram hours.

5. Four cases of cancer of the stomach. One is well 6 years; 1, 8 years; 1, 10 years; and 1, 20 years.

6. Five cases of cancer of the large intestine and rectum. One cancer of the ascending colon is well 17 years; 1 cancer of the transverse colon with obstruction, age 18, is well 12 years; 2 cancers of the sigmoid, 1 is well 16 years and 1 well 12 years; 1 cancer of the rectum, age 76, is well 6 years.

7. Two cases of cancer of the bladder. One had cautery excision and radium, 1,000 milligram hours, and is well 10 years; 1 had cautery excision and is well 10 years.

8. One case of cancer of the urethra had radium, 1,650 milligram hours, with excision of the inguinal glands and suprapubic cystostomy, and is well 10 years.

Unquestionably, the campaign of education of the profession and of the laity by the various agencies upon cancer have done much to enlighten the public and cause our patients to come earlier for examination than formerly; yet it is discouraging still to have many inoperable cases of cancer present themselves for relief, and it is surprising today to have not a few patients request that, if the lesion proves to be cancer, no attempt be made to help them by removing it. This happens frequently and one can interpret the feeling on the part of the patient in no other way except that in the minds of many there remains the firm belief that cancer cannot be cured. Reports of 5 year cures will do much to correct this misbelief and this effort of the American College of Surgeons to collect 5 year cures of cancer and publish them is indeed a noteworthy movement.

If we are to impress the laity with the fact that cancer is curable, let us publish our lists of cures and let us all choose our cases for operation and radiation with greater care.

FOLLOW UP STATISTICS OF FIVE YEAR CURES IN CANCER

FRANK H. LAHEY, M.D., F.A.C.S., BOSTON, MASSACHUSETTS

OF 6,535 patients operated upon for goiter, 187 had definite cancer of the thyroid (2.8 per cent). We can divide all of our thyroid cancer cases into 3 groups: (1), of low malignancy; (2), of moderate malignancy; (3), of severe malignancy. Of the patients with cancer operated upon 5 or more years ago, 17 were in group one, either adenoma with blood vessel invasion or papillary adenocystoma. Of these, 15 are now alive and well. One could not be followed, and one died 5 years after operation not of malignancy. In group two are the cases of adenocarcinoma in which there is some hope of cure. We have 8 cases in this group; one is alive over 5 years after operation and 7 are dead. Group three consists of the almost hopeless malignancies—giant cell and small cell carcinoma and fibrosarcoma. Of these there were 12 cases. One is living over 5 years and 11 are dead.

The salvation of patients with malignancy of the thyroid is in the prophylactic measure of removing adenomata while they are still benign,

since it is in these that practically all malignancy of the thyroid arises.

We have 4 patients alive and well 5 or more years after partial gastrectomy for proved carcinoma or sarcoma of the stomach, 1 at the end of 5 years, 2 at the end of 6 years, and 1 at the end of 9 years. The salvation of patients with carcinoma of the stomach is in early bismuth X-rays of the stomach in all patients with any change of digestive function, loss of appetite, or distaste for food.

Of proved carcinoma of the breast, of 82 cases 28 (34 per cent) are alive and well at the end of a 5 year period. Many of these lesions have been graded as to the degree of malignancy, but time does not permit this discussion.

The salvation of patients with carcinoma of the breast lies in the frequent examination of the breasts by the patients themselves, the examination of doubtful areas by the physician or surgeon, and finally the examination by the pathologist of biopsy specimens from areas considered probably malignant by the examining physician or surgeon.

Of 47 radical resections of the colon and rectum done 5 or more years ago, representing an operability of 45 per cent, 14 (30 per cent) are alive and well now. Nine were early cases without glands, 5 showed local glands or glands in the vicinity of the growth.

The salvation of patients with carcinoma of the colon or rectum is in routine and adequate rectal examinations in all patients examined for whatever cause, in the submission of all patients who have any change whatever in colonic function to early bismuth enemata and fluoroscopy, and in proctoscopy of all patients with rectal bleeding or discomfort.

Surgery had proved that it can produce lasting cures in cancer patients if the diagnosis is made early. Early diagnosis is in the hands of the family doctor and if he is to make more early diagnoses, he must do more than the sometimes merely casual examination—he must make the examination more comprehensive; even then at times he will be compelled to make his diagnosis upon clinical evidence which is not always convincing but only suggestive of malignancy.

THE CURABILITY OF CANCER

NEIL JOHN MACLEAN, M.D., M.R.C.S. (ENG.), F.A.C.S., F.R.C.S. (CAN.), WINNIPEG, CANADA
Associate Professor of Surgery, University of Manitoba; Consulting Surgeon to the Winnipeg General Hospital

CANCER originates in a *single cell*, which has taken on abnormal growth. For a certain definite period of time, then, cancer is a local disease, and, as such, is amenable to cure by radical surgical measures. In assessing the curability of any given case, three factors are of paramount importance: first, the accessibility of the growth; second, the grade of malignancy; and third, the duration and extent of the disease.

When the disease has involved parts far beyond the primary lymph nodes, cancer, from the standpoint of cure, is practically hopeless. If every case were treated by adequate surgical methods at the onset of symptoms, the percentage of cures would rise rapidly.

It goes without saying that a comprehensive knowledge of the mode of permeation of the cancer cells throughout the different organs and tissues of the body, together with an exact knowledge of the lymphatic drainage of the part involved, is absolutely essential to the intelligent treatment of cancer.

Two cases of epithelioma of the hand were brought to my attention some years ago. Both had been operated upon by first class surgeons, with successful removal of the local growth. Nine months later the first patient developed a mass in the axilla. Two years later the second patient developed a mass in the axilla. Both died of dissemination of the growth. It is interesting to note that in neither of these cases was the epitrochlear gland involved, the lymph drainage from the back of the hand passing directly to the axilla.

The next case I saw had had a small ulcerated nodule on the back of his hand for over a month. His family doctor had removed this nodule, and referred the case to me for further consideration because the pathologist had pronounced the growth malignant. I excised the scar widely and as deeply as possible, taking away all the subcutaneous tissue down to the extensor tendons. Two weeks later the lymph glands were removed from the axilla, and radium was inserted. The

glands, though not macroscopically involved, showed cancer cells on microscopic section. This patient is alive and well, 12 years later. The moral is obvious.

It would seem to be a sound surgical procedure to remove the primary lymph glands at some time subsequent to removal of the tumor. Malignant cells en route from the primary growth to the first group of filters are thus given time to reach their destinations where they are held up for some time. The lymphatic vessels do not appear to harbor cancer cells until the glands beyond are first choked and no longer able to receive their cargos from the primary growth. This later removal of lymph glands does not apply where, as in the breast, a block dissection is made of all possibly involved structures.

The series of cures here presented are taken from my own private records. In every case the diagnosis was confirmed by an expert pathologist, at the time of operation. Reliable follow-up records have also been obtained in every case presented in this series. The period of freedom from cancer following operation extends from 5 to 28 years in this group.

CURED CANCER CASES—5 TO 28 YEAR CURES

	Cases	Years
Lip	8	5 to 20
Breast	36	5 to 25
Uterus	9	5 to 16
Stomach	3	7, 9 and 20
Colon and Rectum	14	5 to 28
Tongue	2	10 and 11
Ovary	2	12 and 19
Kidney	2	5 and 8
Skin of Leg	2	11 and 12
Skin of Hand	1	12
Penis	1	17
Bladder	1	8
Total	81	

Cancer of skin of leg and hand—2 cases cured, 11 and 12 years.

One case of cancer of the skin of the leg is of special interest. A medical man had noted an ulcer on the lateral aspect of the leg midway between the knee and ankle. It had been present 4 months and was the size of a 50 cent piece. The biopsy report was "epithelioma." The ulcer was widely excised and the fascia dissected off the underlying muscle. Three weeks later the surface was skin grafted and the popliteal glands removed. No definite glandular involvement was found.

He has had no trouble now over 6 years.

Cancer of the penis—1 case, 17 year cure.

The penis was amputated 2 inches behind the corona and the inguinal glands on both sides removed 3 weeks later.

Epithelioma of the lips—2 cases of carcinoma of the upper lip living 13 and 20 years; 6 cases of carcinoma of the lower lip living 5 to 15 years.

In removing an early growth from the lower lip, a V excision is used, going 1.5 to 2 centimeters beyond the demonstrable limits of the tumor. In larger growths a modification of the Dieffenbach or the Trendelenburg principle is used. The submaxillary and submental lymph nodes on the affected side are removed 2 weeks later, whether palpably enlarged or not. Fifty milligrams of radium screened in platinum and brass and in a rubber tube is placed in the cavity. This is moved at intervals along the length of the dissection, and taken out in from 24 to 36 hours. A modification of Dieffenbach's principle as applied to the lower lip was used in the restoration of the upper lip after removal of the tumor. It is interesting that 1 of the 2 cases of cancer of the upper lip was in a woman.

Cancer of the tongue—2 cases, 10 and 11 year cures.

The case cured 10 years had a hemiglossectomy. Two weeks later a block dissection of the glands of the neck was done on the affected side. The only gland involved was the jugulodigastric; this being the gland which, as Butlin points out, is early involved in cancer of the tongue. It is interesting that though the growth was at the tip of the tongue the submental and submaxillary glands were missed and the more remote jugulodigastric gland involved. In the other case the growth had crossed the midline in the anterior two-thirds. The glands in both submaxillary regions were grossly involved and were removed at two sittings subsequent to the glossectomy. In both cases radium was used after each operation.

Cancer of the stomach—3 cases, 7, 9, and 20 year cures.

The first patient, alive and well 20 years after operation which was done in two stages. A posterior gastrojejunostomy was first done and 3 weeks later a partial gastrectomy. The 2 other cases had a Pólya operation. One patient, having been well for 9 years, developed cancer in the remaining part of the stomach but at some distance from the suture line. This would seem to be a new development of cancer and not an extension of the previous growth.

Cancer of the rectum—1 patient alive and well 28 years after operation and 5 patients are alive and well 5 to 12 years after operation.

In the first patient, still alive and well 28 years after operation, the lower part of the bowel was removed by the old Kraske method, without a preliminary colostomy. The sacral anus, without sphincteric control, has not been found to be a great inconvenience. In the second patient, alive and well 12 years after operation, a permanent left inguinal colostomy was done 18 days before the radical operation. The rectum, the perirectal and the presacral lymph nodes were removed by the sacral route, a blind part of the sigmoid being left below the colostomy. In more recent cases, the two stage abdominoperineal method was used, allowing 3 to 4 weeks between the abdominal and the sacral parts of the operation.

Cancer of the recto-sigmoid—1 male alive and well 13 years after operation and 1 female died of pernicious anæmia 11 years after operation.

In the first case, an abdominoperineal operation was done. The abdominal stage consisted of dividing the inferior mesenteric artery above its anastomotic branch to the marginal loop of the sigmoid, and mobilizing the lower part of the pelvic colon. A temporary colostomy as high up in the sigmoid as possible was then made and the abdomen closed. Not until 6 weeks later did the patient's condition seem favorable for the second stage. This consisted of wide resection of the involved part of the rectum by the transsacral route, the sphincters being saved at the same time. The bowel was reunited over a rubber tube passed through the anus. The colostomy was closed some months later. This man is now in perfect health, and has a normally functioning bowel, with no sign of stricture. The second patient lived 11 years and died of pernicious

anæmia without any sign of recurrence of cancer. When I first saw her, she had acute obstruction, a small perforation, and spreading pelvic peritonitis. The pelvis was drained and a colostomy was established. Three months later an abdominal resection of the strictured segment was done, and the bowel reunited over a large rubber tube passed out through the anus. The colostomy was closed 2 months later.

Cancer of the sigmoid—4 cases, 5 to 12 year cures.

When the growth is sufficiently high up in the sigmoid to allow it to be mobilized to the surface, I have used as the method of choice, the so-called Mikulicz, or three-stage, operation. If there is obstruction, a rubber tube is at once "pursestringed" into the upper part of the loop. The tumor may be left on the abdomen for a few days, or it may be removed at once, as the exigencies of the case demand.

Cancer of the cæcum—1 case, female, 15 year cure; 1 case, female, 12 year cure.

The operation performed in the first case, was resection of the right colon, closure of the end of the transverse colon and an end-to-side ileocolostomy in one stage. This patient, who was only 24 years old at the time of the operation, is still in perfect health.

In the second case, the ends of the ileum and transverse colon were brought out at the side. The spur was later clamped and the opening finally closed.

Cancer of the breast—9 patients, alive and well from 15 to 25 years after operation; 9 patients, alive and well from 10 to 15 years after operation; and 18 patients, alive and well from 5 to 10 years after operation.

Every tumor of the breast should be regarded as cancer until proved otherwise. Even the typical mobile fibroadenoma in one of my cases turned out to be associated with a cancerous growth.

In the 9 cures ranging from 15 to 25 years, no X-ray or radium was used. During this period, the tumor was removed and the incision closed. If the tumor was proved to be malignant by the pathologist a few days later, the patient was taken back to the operating room and a radical operation was performed. Every attempt was made to avoid touching or re-entering the original cavity.

In the 27 cures ranging from 5 to 15 years, a rapid-section biopsy was done at the time of operation. In the management of these cases, three distinct methods of procedure were followed:

First, in cases of cancer age, with a fairly typical clinical picture of carcinoma, a radical Halstead was done immediately.

Second, in cases of cancer age where the diagnosis of carcinoma was doubtful, an amputation of the breast was done first. If the pathologist reported malignancy, the radical operation was forthwith completed.

Third, in younger women with doubtful tumors the growth only was excised; if reported malignant, the radical operation was then carried out.

The ideal method of procedure in doing a radical breast operation is to begin with the dissection of the axilla, and remove in one piece the lower part of the pectoralis major, the pectoralis minor; the fat, and glands from the axilla, the skin and breast including the pectoral fascia down to the ribs. It is important to include in the dissection the highest gland in the apex of the axilla under the axillary vein where it passes over the first rib into the thorax.

In this situation this gland is easily missed.

Cancer of the corpus uteri—3 cases, 5 to 16 year cures; 1 case (sarcoma) 14 year cure.

In carcinoma of the body of the uterus it was formerly my practice to do an abdominal panhysterectomy. I now use the vaginal method, because it can be done quite radically, and with a lower operative mortality.

Cancer of the cervix uteri—5 patients alive and well 5 to 15 years after operation.

Fifty milligrams of radium (screened) was inserted into the cavity of the cervix for 24 hours. Four weeks later a radical vaginal hysterectomy was done, the ureters being retracted laterally, and the parametrium excised widely (Schauta operation). Radium was again used, 50 milligrams being inserted into the cavity originally occupied by the uterus, and left in for 24 hours. I now believe it best to give more intensive pre-operative radiation, and omit the immediate postoperative radiation.

Carcinoma of the bladder—1 case, 8 year cure.

The growth here was fortunately situated in the fundus. It was excised widely through a suprapubic cystotomy incision. The patient was a woman 76 years of age and lived to the age of 84 without any recurrence.

Carcinoma of the kidney—2 cases, 5 and 8 year cures.

The procedure in these cases was the usual nephrectomy plus free removal of the perinephric fat. Into the cavity left was inserted a drainage tube large enough to contain a 50 milligrams capsule of radium. The latter was left *in situ* for 36 hours being moved the length of the capsule at 12 hour intervals. The value of radium treatment in these cases is questionable.

Carcinoma of the ovaries—2 cases, 12 and 19 years.

Simple oophorectomy was done in each case. One patient developed carcinoma in the remaining ovary 19 years subsequent to the first. She refused further operation and finally died of general abdominal carcinomatosis.

CONCLUSIONS

1. The educational campaign by the profession among the laity for the earlier recognition of the signs suggesting cancer and immediate attention thereto, should be persisted in and extended to reach all classes.

2. Every medical teaching center should have a tumor clinic as part of its organization.

3. Some one has said that he who treats cancer should be radiologically trained and surgically minded. I would say that he who treats cancer should be surgically trained and radiologically minded.

FIVE YEAR CURES OF GYNECOLOGICAL CANCER

HOWARD C. TAYLOR, JR., NEW YORK

THE 5 year cures to be reported are drawn from the files of the gynecological service of the Roosevelt Hospital and the patients were treated during the years from 1910 through 1925. These years have witnessed fundamental changes in cancer therapy so that it is not surprising that the majority of the successful cases were treated in the latter part of this 16 year period.

The apparent improvement in results may be attributed to several factors, such as the advent of radium which was introduced into the Roosevelt clinic in 1917 and the use of the high voltage X-rays which was begun in 1924. But besides these technical innovations, there has grown up with us as elsewhere a special sense of responsibility for the patient with suspected or proved cancer. This newer attitude has manifested itself on the one hand in more conscientious efforts at early diagnosis, on the other in the organization of a follow-up clinic as a check upon the efficiency of treatment.

The Roosevelt gynecological service treats on an average about 40 cases of cancer in a year. Its radiological equipment is limited to 140 milligrams of radium and a single high voltage X-ray machine. It is probable that a majority of cancer cases throughout the country are treated in institutions of about this size, so that the rate of cures I shall report may be taken as typical of that which widely prevails throughout the United States or is at least readily attainable.

Before reporting 5 year cures let me state that pathological reports giving confirmation of the diagnosis are on file at the hospital for all of these cases and for all but a few the microscopic slides have been reviewed and the diagnosis verified within the last 2 years.

The treatment of cancer of the cervix has varied greatly over the period noted so that cures must be reported upon special groups dependent upon the type of treatment. From 1910 to 1916 the only significant treatment for cervical cancer was hysterectomy. In these years a total of 126 cases of all stages of the disease were observed. Nine 5 year cures resulted. (For the 113 primary cases, the operability rate was 60 per cent, the absolute 5 year cure rate 7.1 per cent.) Two patients of this period are known to have been living and well 18 and 20 years, respectively, after their operations.

From 1917 to 1920 when radium was first being used, either alone in the advanced cases or as a preliminary to hysterectomy, 84 cases were treated, with 5 year cures in 11. (For the 78 primary cases the operability was 43 per cent, the absolute 5 year cure rate 14.1 per cent.)

From 1921 to 1923 radium was given increasing scope and the indication for hysterectomy was further restricted. Forty-three cases were treated, with 11 cures. (For the 37 primary cases the operability rate was 27 per cent, the absolute 5 year cure rate, 29.7 per cent.)

In the years 1924 and 1925 when radium was used almost exclusively, 46 cases were treated, with 5 year cures in 8. (The absolute 5 year cure rate for the primary cases was 18 per cent).

The cases of carcinoma of the corpus have been treated more or less uniformly throughout the period and only one-fifth of the primary cases were regarded as inoperable. Of the total of 90 primary and recurrent cases there are 22 known cures. (This represents an absolute 5 year cure rate of 25.8 per cent in the 85 primary cases.)

The cases of carcinoma of the ovary can also be reported as a single group but offer a discouraging figure since only 5 cases out of a total of 66 are known to have been well after 5 years. (The 5 year cure rate for the 58 primary cases was 8.6 per cent.)

Among the less common forms of gynecological cancer there can be reported 5 year cures in 4 among 17 cases of cancer of the vulva and 1 in 7 cases of vaginal cancer. Among a miscellaneous group consisting of 1 case of primary tubal cancer, 3 cases of chorio-epithelioma, 3 cases of myosarcoma of the uterus, 4 cases of sarcoma of the ovary, and 16 cases of generalized peritoneal carcinoma of undetermined origin there were no cures.

To summarize, the Roosevelt clinic has to offer the following 5 year cures:

TABLE 1.—TOTAL FIVE YEAR CURES

	5 year cures	Total cases
Cancer of the cervix	39	299
Cancer of the corpus	22	90
Cancer of the ovary	5	66
Cancer of the vulva	4	17
Cancer of the vagina	1	7
Miscellaneous	0	27
Total	71	506

TABLE II.—EXTENT OF DISEASE WHEN TREATMENT WAS INSTITUTED

	Early		Intermediate		Advanced	
	Total cases	Percentages	Total cases	Percentages	Total cases	Percentages
Cervix	24	8	31	17	224	75
Corpus	26	29	27	30	37	41
Ovary	9	14	16	24	41	62
Vulva	19	53	7	41	1	6
Vagina	1	14	0	0	6	86
Miscellaneous	0	0	1	4	26	96
Total	69	14	102	20	335	66

The total number of cancer cases treated in these years was 506, so that it may be said that approximately 1 woman in 7 who came for treatment was well for at least 5 years after her treatment.

The figure of 1 in 7 represents an absolute minimum inclusive of all advanced and recurrent cases, and with the acceptance as failures of all cases that could not be traced. Table II giving a somewhat arbitrary division of cases according to the extent of the disease, shows that almost two-thirds of the cases were advanced when they first came for treatment. From this table it becomes clear that the unfavorable character of cancer statistics is, of course, determined by the vast preponderance of the late and unfavorable cases.

TABLE III.—PERCENTAGE OF FIVE YEAR CURES AMONG TRACED CASES IN DIFFERENT STAGES OF THE DISEASE

	Early	Intermediate	Advanced
Cervix	75	41	8
Corpus	63	50	0
Ovary	33	31	0
Vulva	50	0	0
Miscellaneous	100	0	0
Total	63	37	5

A more encouraging outlook is obtained from Table III which shows that 5 year cures may be hoped for in over one half of the early and in over one-third of the intermediate cases.

The failure of efforts to reduce more materially the percentage of patients who come for treatment in an advanced stage of the disease is a discouraging aspect of the present status of cancer control, but the relatively great success being obtained in the treatment of the favorable cases remains a strong incentive to continued striving for earlier diagnosis.

CANCER OF THE CERVIX AND CANCER OF THE BREAST

Five Year End-Results in the University of California Hospital

FRANK W. LYNCH, M.D., F.A.C.S., and EDWIN I. BARTLETT, M.D., F.A.C.S., San Francisco, California

THIS is a summary of the 5 year cures in a series of 222 cases of proved carcinoma of the cervix treated in the University of California Hospital between March 16, 1916, and September 30, 1927. No case has been lost in the follow-up since treatment. Seven patients died of intercurrent disease during the 5 year observation and 4 died following surgery. These are charged as cancer deaths.

The cases are grouped into the four stages adopted by the American College of Surgeons.

Stage I. Cancer limited to the cervix.

Stage II. The cancer may have reached one or the other of the vaginal fornices but there is no demonstrable extension to the parametrium. The uterus is still mobile.

Stage III. The cancer has extended beyond the cervix and definitely invaded the parametrium. The uterus is fixed.

Stage IV. The cancer forms a mass which fills the pelvis, may have grown down on the vaginal walls, may or may not have fistula, and represents the last stages of the disease.

Stage V. Recurrent cases.

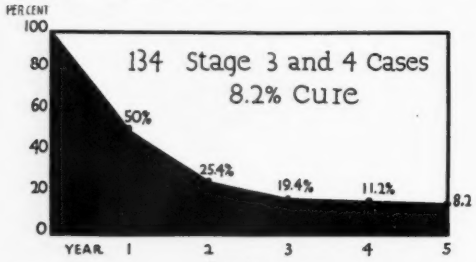

Chart 1.

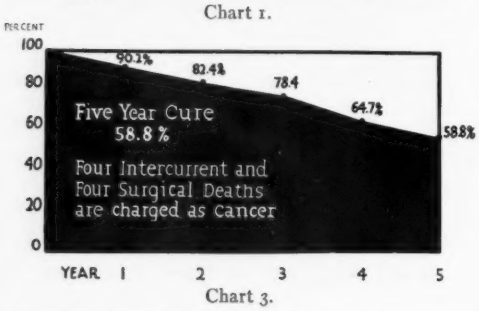

Chart 3.

Chart 1. Cancers of uterine cervix.

Chart 2. Percentage of cures found in the various stages.

Type of material. The series comprises 185 cases in which the cancer was first treated by me (Lynch) and of 37 in which a hysterectomy was done by others and radiated subsequently by me, either as prophylaxis or as treatment of known recurrence.

Results of treatment. Stage I. Of the 19 cases, 17 are living and well 5 years after treatment. There were two intercurrent deaths charged as cancer. One died from a paralytic stroke 5 months after surgery and 1 of heart disease 4 years after radium treatment. Symptomless cancer was found in the latter patient at autopsy in both the right and left hypogastric glands. The cure for this group is 89.5 per cent.

Stage II. Of the 32 cases, 13 were living and well at the end of the 5 year observation period, a cure of 40.6 per cent.

Stage III comprises 85 cases with only 11 survivors, a cure of 12.8 per cent.

Stage IV consists of 49 cases. No five year survivors. Forty-four of the 49 died within the

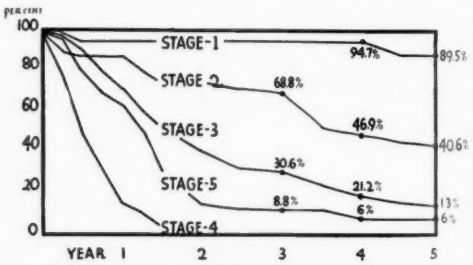

Chart 2.

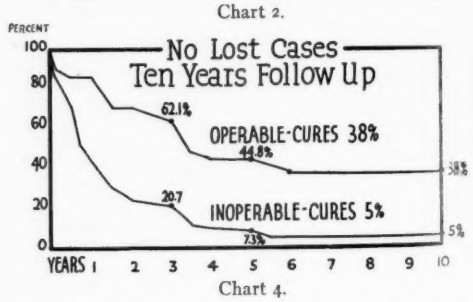

Chart 4.

Chart 3. Cancers of the uterine cervix, 51 cases, stages 1 and 2.

Chart 4. Carcinoma of the cervix, 111 cases.

first year and all but one within a year and 3 months. The extremely large percentage which cancers of this stage form of all inoperable cases reduces the total cure of the inoperable cases to figures less than those from other clinics that had learned earlier than we that it is useless to treat them.

Stage V. Of 37 patients of this group 4 were 5 year survivors, a percentage of 10.8.

SUMMARY

The 5 year cure for the entire series is 20.3 per cent including those in Stage V, or 22.2 per cent for the 185 patients for whose first treatment we were responsible.

Combining the cases in Stages I and II, we find 5 year cures of 58.8 per cent for this early and "borderline as to operability" group.

Combining the 85 Stage III and 49 Stage IV cancers, we find a cure of 8.2 per cent.

The entire series consists of 222 treated cases with 45 survivors.

CONCLUSIONS

This study shows that a cure may be confidently expected in early cervical cases following proper treatment.

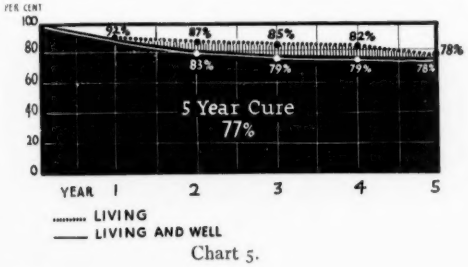

Chart 5.

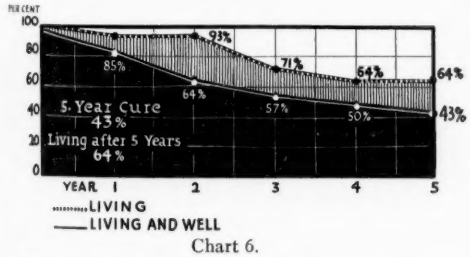

Chart 6.

Chart 5. Carcinoma of the breast, Group A1, 39 cases, primary without axillary metastases, local conditions favorable.

Chart 6. Carcinoma of the breast, Group A2, 14 cases, primary without axillary metastases, but with unfavorable local conditions, such as large tumor, tumor in an inner quadrant, etc.

TABLE I.—CARCINOMATA OF THE BREAST, 156 CASES

	Cases	Per cent
Group A1	39	
Group A2	14	
Group B1	34	
Group B2	69	
Lost from follow-up	9	
Death—intercurrent	4	
Death—surgical	1	
Death—cancer	81	
Living and well	50	32
Living—recurrence	11	7

CARCINOMA OF THE BREAST

This is a summary of the 5 year results in 156 cases of carcinoma of the male and female breast treated at the University of California Hospital between January 1, 1918, and October 1, 1927. The cases have been placed in four groups, according to prognosis as judged by the operative finding.

Group A1 includes primary cases without axillary metastases and with favorable local conditions, such as small tumor, tumor in an outer quadrant, etc.

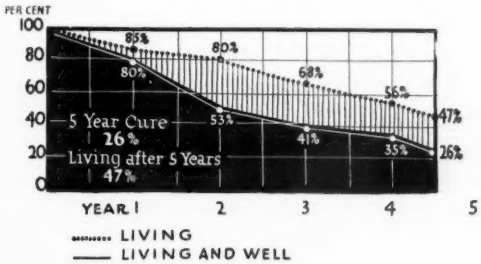

Chart 7.

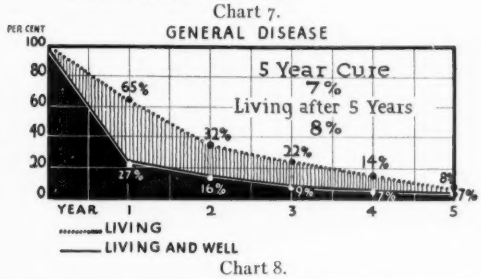

Chart 8.

Chart 7. Carcinoma of the breast, Group B1, 34 cases, primary with metastases, local conditions favorable.

Chart 8. Carcinoma of the breast, Group B2, 69 cases, primary carcinoma with metastases and with unfavorable local conditions, extensive involvement, inner half, etc. Recurrent carcinoma, limited involvement, no evidence of general disease.

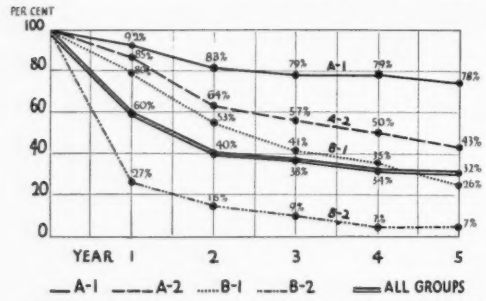

Chart 9. Five year results in 156 cases of carcinoma of breast.

Group A2 includes cases also without axillary metastases, but with unfavorable local conditions, such as large tumor, tumor in an inner quadrant, etc.

Group B1 includes primary cases with axillary metastases but with favorable local conditions.

Group B2 includes also primary cases with axillary metastases but with unfavorable local conditions, and also secondary cases without evidence of general disease, or extension of disease externally beyond surgical reach.

Material. The series comprises 93 cases treated by me (Bartlett) and 63 cases treated by several others. All had a radical operation, and all of mine were treated by the method which I have previously described.[1]

Results of treatment. Group A1. Of the 39 cases treated, 30 are well after 5 years, thus making 78 per cent cured. Of the 9 charged against cancer death, 3 were lost in the first year; 1 died of bronchopneumonia in the second year, and 1 died of pernicious anæmia, without any trace of cancer, in the third year after treatment. Four actually died of cancer.

Group A2. Of the 14 cases treated, 6 are well 5 years after treatment, thus making 43 per cent cured. All the deaths were due to cancer. This illustrates the increased mortality from cancer in an inner quadrant.

Group B1. Of the 34 cases treated, 9 are living and well, 5 years after treatment, thus making 26 per cent cured. Out of the 25 charged against cancer death, 3 were lost, thus 22 actually died of cancer.

Group B2. Of the 69 cases treated 5 are living and well 5 years after treatment, thus making 7 per cent cured. Of the 64 charged against cancer death, 3 were lost, 1 died following operation, and 2 died of intercurrent disease, thus making 58 who actually died of cancer.

[1]Surg., Gynec. & Obst., 1931, lii, 71–78.

SUMMARY

There were 5 year cures in 32 per cent of the entire series. The life expectancy in Group A1 (with favorable local conditions and without axillary metastases) is nearly twice as good as that in Group A2, (where the local conditions are unfavorable), and is three times as good as in Group B1, (which had the same favorable local conditions but with axillary metastases). The life expectancy in the groups without metastases (A1 and A2), is double that of B1 alone. If we exclude Group B2 in which the majority of cases gave no hope of cure from the clinical findings alone, the hopeful clinical case with or without metastases should have a 50 per cent chance of cure.

CANCER OF THE CERVIX UTERI

Statistical Study of One Thousand Five Hundred and Seventy-Eight Patients Treated at the Howard A. Kelly Hospital Between January 1, 1911, and September 30, 1927[1]

CURTIS F. BURNAM, M.D., F.A.C.S., Baltimore, Maryland

CANCER of the uterine cervix, when treated in its incipiency, is curable in nearly every case. The possibilities of cure steadily diminish as the disease advances until it becomes an incurable and fatal malady.

A review of the records upon which this paper is based demonstrates that a considerable proportion of the hopeless and far advanced cases are in these stages because of the ignorance and carelessness, not only of the patient, but frequently of her medical advisers.

While the methods of employing existing means of treatment are steadily being improved, it is evident that more can be gained in treating this disease by education, which will bring patients in for treatment during the earlier stages of the cancer. At this writing, about 50 per cent of the cases which present themselves for treatment at The Johns Hopkins Hospital are operable, but only a very small proportion of these are in the very early stage in which the disease is limited to the cervix.

In order to study the results obtained by treatment of the 1,578 cases which presented themselves in the period between January 1, 1911, and October 1, 1927, they have been grouped under five distinct headings: operable, prophylactic, inoperable, recurrent, and palliative.

At this hospital the principal method of treatment has been by radium and, secondarily, by surgery and X-ray. The relatively small percentage of operable cases is due to the fact that the sources from which these cases came, during these years, principally relied on surgical methods alone in the treatment of the operable cases coming to them. Slightly over 13 per cent of all cases treated have been early enough to be classified as operable.

In addition to the anatomical extent of the disease, the results are dependent upon technique employed in treating, and upon the type and grade of malignancy found on microscopical examination. Time does not permit, however, of a consideration of the influence of these factors upon the 5 year cure rate.

Let us now consider the five headings under which our cases are grouped.

Operable cases. Under this caption are included all the stages except those presenting firm fixation through the parametrial and paravaginal tissues to the pelvic wall and those with definite palpable glandular metastases. It comprises not only the operable but borderline cases. It includes the vaginal extensions, no matter how estensive, and the parametrial involvements which do not extend as far as firm fixation to the pelvic wall. All of these cases are cases treated with radium, or radium and X-ray.

Prophylactic cases. These cases represent the same extent of trouble, or perhaps a little less than in the first group. They are differentiated because they were first treated by surgical removal and then by postoperative radiation.

Inoperable cases. Under this caption are included all those cases which present firm fixation to either one or both pelvic walls through the parametrial or paravaginal tissues. Most of these patients presented extensive vaginal extensions of the disease. Excluded from this group are cases with general or with demonstrable extensive local glandular involvement.

Recurrent cases. Under this title are included all recurrences which have followed the surgical removal of the uterus for cancer of the cervix. In these cases the extent of the disease present at the time of treatment varied greatly.

Palliative cases. Under this caption are placed all cases showing general metastases, or extensive local glandular metastases. Most of them have been associated with massive local fixation. The treatment given has been not to cure, but to stop bleeding or to alleviate pain.

THE RESULTS OF TREATMENT

In Table I, is shown by years, the total number of cases treated, the total number of cures, and the percentage of cures for cases treated; and then the total group is divided into the five divisions indicated, and for each group the number of cases, the number of cures and the percentage of cures are shown. This table refers to 5 year cures. No case is included except when 5 full years have elapsed from the time of treatment and when most careful clinical examination demonstrates no

[1] These cases were all treated by Howard A. Kelly, William Neill, and the author, at The Howard A. Kelly Hospital, and most of them have been seen by at least two of us.

TABLE I.—DISTRIBUTION OF CASES FROM JANUARY 1, 1911, TO OCTOBER 1, 1927

Total Number of Five Year Cures and Percentages in the Different Groups

	Total cases	Cured cases No.	%	Operable No.	%	Prophylactic No.	%	Inoperable No.	%	Recurrent No.	%	Palliative No.
1911	13	3	23.07	2 2	100	0 0	0	4 0	0	5 1	20	2
1912	10	2	20.00	1 1	100	1 1	100	4 0	0	4 0	0	0
1913	34	4	11.76	3 3	100	1 1	100	12 0	0	18 0	0	0
1914	106	13	12.26	5 3	60	3 2	66.66	51 4	8	42 4	9.9	5
1915	82	11	13.41	6 2	33.3	1 1	100	42 3	7.14	30 4	13.3	3
1916	109	13	12	2 2	100	6 4	66.66	57 3	5.3	40 4	10	4
1917	79	13	16.45	2 2	100	4 1	25	46 8	17.4	21 2	9.5	6
1918	102	15	14.7	4 2	50	3 0	0	73 13	17.8	19 0	0	3
1919	158	26	16.45	13 6	46.1	9 4	44.44	102 11	10.7	26 4	15.3	8
1920	169	21	12.41	13 8	61.5	7 1	14.3	104 9	8.65	33 3	9.3	12
1921	130	19	14.61	17 6	35.3	2 0	0	83 12	14.4	16 1	6.25	12
1922	88	14	15.9	5 2	40	1 0	0	57 5	8.77	15 7	46.6	10
1923	107	17	15.9	10 5	50	4 2	50	80 9	11.2	9 1	11.1	4
1924	113	18	15.94	11 8	72.7	5 3	60	81 7	8.64	8 0	0	8
1925	112	23	20.53	22 12	59	6 2	33.33	70 7	10	7 2	28.5	7
1926	102	21	20.58	20 6	30	4 2	50	66 12	18.1	6 1	16.6	6
1927	64	19	29.68	12 11	91.6	3 1	33.33	37 7	18.9	3 0	0	9
	1578	252		148		60		969		302		99

TABLE II.—COMBINATION OF ENTIRE 1578 CASES SHOWN IN TABLE I

	Cases	Cures	Per cent
Cured		252	15.96
Operable	148	81	54.73
Prophylactic	60	25	41.66
Inoperable	969	110	11.35
Recurrent	302	34	11.25
Palliative	99		

Percentage of frequencies of cases in the five groups

	Per cent
Operable	9.37
Prophylactic	3.80
Inoperable	61.40
Recurrent	19.13
Palliative	6.27

Ten year results on cases treated prior to October 1, 1922.

Total number of 5 year cured cases	150
Living and well at end of 10 years	110
Dying of recurrence from sixth to tenth year	16
Dying of other forms of cancer from sixth to tenth year	8
Dying of other disease	6
Followed for 7 years or longer and now being investigated	15

The oldest cured cases 3 well for 21 years—2 of them extensive borderline, and 1 extensive recurrence.

trace of the disease. The cases of patients dying from other causes than cancer, as well as all the cases of patients who have not been traced are placed in the uncured class. In our entire series, there are 41 cases in which a clinical cure was known to be present for several years, but, as yet, we have been unable to trace the patients and make sure of the final result. Of these 41 cases 22 were inoperable, 9 were operable, 5 were recurrent, and 5 prophylactic. The variations in percentages of cures depend, in part, on the distribution as to extent of disease; in part, perhaps, on the varying techniques employed; and, in part, on the types and grades of malignancy. It beautifully demonstrates, however, the limitations which must be put on drawing deductions from a small series of cases, such as is presented by any one year.

In Table II are shown the combined results of the entire series of cases, as well as the results obtained in each of the five groups for the 5 year period. In addition, the relative percentage frequencies of each of the five groups is shown, and also the 10 year results on the cases which were well at the end of 5 years. Finally, the results are given in the cases treated in 1911, which was the first year of this series.

While 5 years is an arbitrarily accepted standard for a cure, it must be constantly kept in mind that recurrences may take place after this period. However, it is of interest that we have had only one recurrence after 12 years, and this might be interpreted as a primary new-growth, as it occurred in the lungs. Taking the period prior to October 1, 1922, there were 150 5 year cure cases. At the end of 10 years only 110 were still living and well, as shown by examination. Of the 40 cases remaining, 16 died of recurrences between the sixth and tenth year; 3 died of cancers of a different type developing *ab novo*. It may be of interest here to mention 2 cases, in 1 of which the patient was cured of a cervical cancer for 10 years, and is now cured of a breast cancer for 4 years; the second was cured of a cervical cancer for 6 years, and of an antral cancer for 3 years.

Fifteen patients, who were traced from periods varying from 7 to 10 years, have been temporarily lost sight of. Six cases, after the 5 year period died of other causes than cancer.

It is of interest that the 3 cured cases of the year 1911, 21 years ago, are all still well. Two were extensive borderline operable cases, and one an extensive recurrent case.

CANCER OF THE PELVIC ORGANS

W. E. CALDWELL, M.D., F.A.C.S., NEW YORK

THE experience of a general hospital with a gynecological service would seem to be instructive. In the Sloane Hospital up to 1929, cancer of the female reproductive organs was treated as part of the regular routine service. Those requiring operative treatment were skilfully handled. Those requiring other forms of treatment, radiotherapeutic, electrical, and heat, were handled according to the intensity with which the particular therapeutist happened to have studied that particular field. In cancer of the cervix, experience with radium is of interest. The follow up studies show a 5 year cure in 7 cases of 21, or 33⅓ per cent of those in which the process was limited to the uterus; but in those in which the process had spread to the vagina or broad ligaments, in only 16 cases of 94, or 6 per cent. (All patients not followed are classed as dead.) In reviewing the dosage of radium, the greatest variety is seen; varying from one barely sufficient to produce an artificial menopause to one which, according to present standards would be considered adequate. Similarly the study of the follow-up statistics of these cases shows a great unsatisfactory variation. Those physicians who were interested obtained results far superior to those who treated women merely as a part of the routine.

In 1929 a group was organized within the Department of Obstetrics and Gynecology, composed of two members of the staff who co-operate with the Department of Pathology and the Department of Radiotherapy. Into their hands was placed the responsibility for all radium treatment and the pre-operative and postoperative conduct of the cases. Since this time the operative treatment has gone on as before. The efficacy of the radium treatment, on the other hand, as indicated by the 3 year results has advanced greatly and the follow-up clinic shows a return of 98 per cent.

The moral from this experience is that the treatment of a disease such as cancer, of insidious onset and prolonged course, whether favorable or unfavorable, requires an interested group equipped to carry out any diagnostic procedure or any therapy, and organized to maintain constant contact with a cancer patient from the time such a condition is suspected. Whether this group should function as a subgroup under one of the therapeutic specialties, as radiotherapeutics, or of a cancer clinic or, on the other hand, as a subgroup of the gynecological department is a matter of debate. In this disease it is felt that above all else, early diagnosis is important and that by having the gynecological cancer cases diagnosed and followed in the gynecological clinic, the losses caused by the referring of the patient from one department to another will be minimized and the patients brought earlier to treatment. Moreover, the treatments themselves are within limits fairly well standardized. Operative techniques have varied very little for many years. The use of radium as developed in different centers in many parts of the world has gradually worked out so that the principles of the techniques are fundamentally the same, and the results in large groups show unimportant variations.

RESULTS OF TREATMENT OF CANCER OF THE UTERUS AT THE MASSACHUSETTS GENERAL HOSPITAL

LINCOLN DAVIS, M.D., F.A.C.S., Boston, Massachusetts

I AM glad to take part in a symposium on cases of cured cancer for I am sure that in spite of all the good work done by various organizations in spreading a note of hopefulness in the treatment of cancer there is still a very widespread feeling that the disease is hopeless and incurable. This feeling exists not only among the laity but also with many general practitioners. Each of the latter sees relatively few cases in his own practice, and, if there happen to be a consecutive number of bad results, naturally the practitioner becomes pessimistic about the situation. If large series of cases are analyzed, however, it is found that there is a very respectable percentage of arrests of the disease or cures.

With the laity the situation is even worse. The average person is fond of talking about his or her operation, but I have never heard any one talk about having had an operation for cancer. As a matter of fact the patient is usually entirely unaware of the existence of the disease in his own case, the secret having been carefully guarded by the doctor as well as by relatives and friends. This was forcefully brought home to me a number of years ago when in talking with a friend, a very intelligent man and a prominent attorney, I told him that I had been giving a talk on cancer. He said, "As a matter of fact, has a case of cancer ever been cured?" This man himself had been operated on some 15 years previously for cancer of the sigmoid flexure, by the late John W. Elliott of Boston, who performed an entirely successful removal with suture of the bowel. However, this highly intelligent and generally well informed man was entirely unaware of the fact that he himself represented a cure of a very malignant form of cancer of the bowel. On the other hand, when a patient succumbs after an operation or following a long illness it is quite generally circulated that "poor so and so had cancer." So that the brilliant results are carefully hidden while the fatal cases are thoroughly discussed. Therefore, I think the American College of Surgeons is to be thoroughly commended for persistently keeping this aspect of the subject before the profession and the public.

I am convinced that a large number of cases of cancer have been cured in the past, a still larger number are being cured at the present time, and even greater prospects lie before us in the future.

I wish to present a brief report of the results of treatment of cancer of the uterus at the Massachusetts General Hospital. These results may not seem brilliant; the figures are not perhaps as large as one might expect but it should be remembered that this is a general hospital specializing in no way in gynecology. In fact for several years following the year 1922 when it began to become evident that the results of radium treatment of cancer of the cervix were at least as good if not better than the results following radical operation, patients with this disease at the General Hospital were as a rule referred to other institutions for treatment, as the Massachusetts General at that time had no radium. It was not until the year 1925 that radium treatment of cancer of the cervix was begun on a very small scale, so that the opportunities for reporting 5 year "cures" following its use are extremely limited. Nevertheless, the results have been distinctly heartening, encouraging us to continue and increase its use with substantial abandonment of hysterectomy. The next few years will show whether or not our confidence has been well founded.

The standard of cure generally adopted in compiling cancer statistics, the so called 5 year "cure," consists of an observation period of 5 years following treatment, at the end of which time the patient is living without discoverable signs of the disease. This standard has been followed in this report but it should, of course, be understood that the term is used in a relative rather than an absolute sense, and that the period of 5 years merely represents a lapse of time which indicates that future recurrence is relatively unlikely. Recurrences are most frequent in the first 2 years after treatment, and progressively diminish thereafter. Three years has been proved an insufficient period of observation. Recurrences, unfortunately, do take place after 5 years or even after 10 or 20 years, or at any period.

In this report 4 patients, who have been included among the cured cases, having been reported living and well at the end of 5 years, died of undoubted recurrence at the end of 6, 7, 8, and 15 years, respectively. On the other hand, 2 patients reported well by letter at the end of 5 years who died of abdominal metastases early in the sixth year are not included. If an absolute cri-

terion of cure were demanded it would be necessary to establish the freedom of the body from recurrence by a complete autopsy after the death of the individual, an obvious absurdity.

Interest in the operative treatment of cancer of the cervix at the Massachusetts General Hospital started in 1901 when Dr. Farrar Cobb began doing a modified Wertheim operation. He later was given the assignment of all cases in the hospital. In 1920[1] Dr. Cobb made a report of his results with the radical operation showing 5 year "cures" in 11 of 26 cases, or 42 per cent.

In 1915 the assignment of the operative treatment of cancer of the cervix came into my hands. I reported before the American Surgical Association in 1922[2] the end-results of my work with the radical operation, showing 8 cases of survival of 5 years or more without recurrence in 20 cases followed up, or 40 per cent.

In 1925, as before stated, we began the use of radium at the hospital in a small way, at first only for the advanced cases of carcinoma of the cervix. Gradually, however, radium supplanted radical operation in the treatment of the more favorable cases, and only two radical Wertheim hysterectomies have been done since 1925.

I have, personally, performed a total of 43 hysterectomies for cancer of the cervix at the General Hospital. Four of these patients have not been traced. Of these 43 proved cancer cases, 16 patients survived the operation for 5 years without signs of recurrence, or 37 per cent. Two patients have survived for 16 years and are in good health today. One of these showed definite invasion of the parametrial tissue removed.

The radium cases are limited in number and comprise 11 cases of 5 year "cures." The earliest of these was treated in July, 1925. There were 2 cases in which radical hysterectomy was preceded by radium treatment. One of these resulted in a cure which has been credited perhaps somewhat arbitrarily to the hysterectomy.

In estimating the value of any form of treatment it is important to know what proportion the successful cases bear to the whole number seen or treated. In 1925 there were 15 cases of carcinoma of the cervix treated with radium, with 5 cases of 5 year "cures." In 1926 there were 24 cases treated, with 2 cases of 5 year "cures." In 1927, up to September, there were 25 cases with 4 cases of 5 year "cures." Altogether, 64 cases were treated with radium with 11 cases of 5 year "cures," or 17 per cent. There was no selection of cases; only the moribund were excluded.

[1] J. Am. M. Ass., 1920, lxxiv, 14-17.

[2] Ann. Surg., 1922, September.

An analysis of the records of patients operated upon by me personally shows that something over 30 per cent of all cases seen were subjected to radical operation. A percentage that was perhaps unduly high for the best operative results. In the 42 radical abdominal hysterectomies and 1 vaginal hysterectomy, there were 4 operative deaths, a mortality of 9.5 per cent. There has been no mortality in the cases treated with radium.

Cases of adenocarcinoma of the body of the uterus have been treated by hysterectomy as a first choice, radium being used only if distinct contra-indication to a major operation existed. In carcinoma of the body of the uterus as contrasted with carcinoma of the cervix, the operability rate is relatively high and the mortality rate relatively low. Furthermore the disease is of relatively slow growth metastasizing outside the uterus at a late stage, so that the total abdominal operation gives exceedingly good results, superior in our hands to the application of radium which involves some danger of perforation or hæmorrhage, and at best is a blind procedure.

In an analysis of 50 cases of adenocarcinoma of the body of the uterus at the Massachusetts General Hospital, made in 1925[3], I found over 60 per cent of 5 year "cures." This compares favorably with the results of the treatment of cancer anywhere in the body, excepting only superficial lesions of the skin.

During the past year Dr. J. V. Meigs has undertaken an intensive follow-up study of all the cases of cancer of the uterus at the hospital, during the last 20 years, checking up and reviewing the pathological specimens and throwing out all doubtful cases, and all cases in which the pathological specimens have been lost, also, personally, examining surviving patients. A few cases recorded as cures in previous reports have been excluded in this rigid review. The follow-up has not yet been completed, and it is fair to expect that some additional cures will be found. I am greatly indebted to Dr. Meigs for the use of his data.

As a result of this review to date, it is found that there are at the Massachusetts General Hospital complete records of 64 women who had microscopically proved cancer of the uterus who have survived treatment for at least 5 years without signs of recurrence, so called 5 year "cures." Of these patients 34 had carcinoma of the cervix, and of these 23 had radical hysterectomies, and 11 were treated with radium. Thirty patients had carcinoma of the body of the uterus; of these 28 were treated by hysterectomy, either vaginal

[3] Ann. Surg., 1925, July.

or abdominal, and 2 were treated with radium. Slightly over one-half of these cases were personal ones, the others were treated by colleagues on the hospital staff.

GYNECOLOGICAL CANCER

W. A. G. BAULD, M.D., F.A.C.S., MONTREAL, CANADA

ON the plea of this College to establish a faith in the curability of cancer in the minds of the medical profession and the public in general, I come to add a contribution from the Royal Victoria Montreal Maternity Hospital, Montreal, Canada.

The figures I regret are small but represent the first series available over the prescribed 5 year period. The percentage cured and remaining well in this series is 26.6 (4 out of 15).

The care of the cancer patient applying to a large gynecological clinic offers peculiar and special difficulties. We have all seen the sacrifices to inexperienced treatment—the fatal delay in the undiagnosed case—the careless patient who does not follow advice and must be searched out and driven in when delinquent and who will return only on the appearance of urgent and late symptoms. We all know the neglected and pitiful state of the dying cancer patient and we all know how easily they fall prey to the designs of "unscrupulous cancer cure schemes." They require guidance and protection as well as treatment and comfort.

While all will admit the benefits accruing from large and specialized cancer clinics with every facility for treatment and research, it is not yet possible for these institutions to reach all the sufferers first hand and frequently the best chance is lost through inexperienced and damaging or incomplete treatment.

There remain of necessity a great number of patients who must be treated in the clinics of their vicinity and it was these factors which stimulated the formation of a subdivision of our main gynecological department under what is known as the Cancer Clinic and from which these results come.

A few words of the formation and activities of this unit I think, may be of some assistance to those similarly situated. The immediate direction of the unit was placed under one member of the existing general staff trained and practicing gynecology in all its branches. He was required to make a special study of gynecological cancer in all its phases and the most efficient methods of treatment—needless to say this implied a study of radium and other radiological methods and their appropriate uses. To the group was added a second member of the staff with special training in laboratory methods and pathology, so bringing this important factor into intimate interest with the problems. This move has proved extremely valuable in the clinical work.

An adequate supply of radium was provided for the work and the care and use of the radium is entrusted to the members of this subgroup; this I believe important to insure the safe and proper use of radium when required for cases other than cancer.

Accessible X-ray facilities are available through the main hospital X-ray department but with an increased growth of the clinic it is evident that suitable and special apparatus may be advantageously placed near the special clinic.

Records and follow-up comprise a most important branch of the work and requires unusual interest and fidelity to the work. I am happy to tell you that this work has been well done and that only 8 of a total of 228 during the activities of the clinic have escaped observation over a period of 6 years.

In conclusion may I emphasize the following points:

1. Cancer patients applying to a gynecological clinic should be segregated into a special clinic.
2. This clinic should be under the direction of a clinician who has special knowledge and experience in radiological methods.
3. Special records and an accurate follow-up are vital to results.
4. Results may be obtained equal to the larger and more favorably equipped special cancer clinics.

CANCER OF THE BREAST

J. M. T. FINNEY, M.D., F.A.C.S., BALTIMORE, MARYLAND

WHEN a woman consults a surgeon for a lump in her breast, one question and one only, of paramount importance, at once presents itself to the surgeon for answer, namely, "Is this lump cancer or is it not?" All other questions but this can await an answer. This one cannot, and until it has been answered beyond all question of doubt, the first duty of the surgeon to his patient will not have been discharged. As soon as the diagnosis of malignancy has been definitely determined, the combined judgment of experienced surgeons and pathologists demands the immediate removal *en masse*, by surgical operation, of the entire breast and all adjacent structures that may possibly be invaded by the growth. Until complete extirpation with a wide margin, by clean dissection, of all suspicious tissues has been accomplished, the second great obligation of the surgeon to the patient with cancer of the breast will not have been discharged. In the present state of our knowledge, there can be no possible excuse for failure to recognize cancer of the breast, or to apply promptly the only effectual remedy, namely, its radical removal as described by Halsted in his epoch-making communication in 1894.

That cancer of the breast, as elsewhere, is curable, and that cancer of certain types and in certain regions of the body is more amenable to treatment than in others, are established facts. Because it is not a vital organ, and owing to its anatomical structure, the breast lends itself readily to thorough examination and complete removal. The one thing yet lacking in securing the maximum number of cures is the active intelligent co-operation of the patient. She must, somehow, be impressed with the absolute necessity of consulting her physician at the first sign of any trouble in the breast. This is the crux of the whole matter.

My contribution to this discussion is based upon a study recently made by Lewis and Rienhoff, of 950 consecutive cases of cancer of the breast, many of them my own, operated upon in the Johns Hopkins Hospital, over a period of 42 years, from the beginning of the hospital in 1889 to 1931, by 38 different surgeons. Of this number, 517 cases operated upon more than 5 years have been traced and their present condition is known. Of this number, 135 (26 per cent) lived from 5 to 32 years following operation. While this percentage of cures compares favorably with other statistical studies, it must not be forgotten that over 50 per cent of the cases were operated upon by members of the resident staff, and that the period covered runs back to the very beginning of the Halsted operation, when cases were very late in coming to operation.

The recital of these results will at once suggest to the mind of every thoughtful surgeon two ideas: (1) how comparatively small is the number of cures obtained; and (2) the query "By what means may this number be materially increased?"

Four significant facts emerge from a symposium such as this: (1) That cancer is curable, or, what amounts almost to the same thing, it may be held in abeyance for an indefinite term of years, by timely radical surgical measures. (2) That early diagnosis is essential to success. (3) That the most radical excision of the growth is alone productive of the best results. (4) That in the present state of our knowledge any improvement in our percentage of cures must come through educating the patient to seek earlier advice. The physician is not always blameless in failing to refer his patient at once to a competent surgeon, and the surgeon himself is not always sufficiently radical in his removal of tissues, to give the patient her best chance. In all three of these directions improvement may be made.

CARCINOMA OF THE CERVIX UTERI

Combined Statistics of Patients Treated in the Cancer Clinic of the Woman's Hospital in New York, Series from 1919–1927, with a Five Year Observation Period

GEORGE GRAY WARD, M.D., F.A.C.S., New York

WE have previously published statistical reports of the 5 year results we have obtained with radiotherapy of carcinoma of the cervix uteri at the Woman's Hospital in 1925, 1928, and 1930. We now have two more 5 year series to report, making 8 series in all covering a period of thirteen years.

During this time I have had under my direction some 560 odd cases of cancer of the cervix and more than 100 cases of carcinoma of the fundus. There are 357 cases of the cervix in which the 5 year observation period has been completed, and this group forms the basis for this statistical report.

The important features of our technique as previously published are a personal follow-up each month of all cases throughout the 5 year period as far as is possible, the employment of blood transfusions before or shortly following radiotherapy in all anæmic or cachectic patients, and the re-radiation of metastatic recurrences in the vaginal tract in their incipiency when discovered in the follow-up clinic. Our initial dosage averages from 3,600 to 4,200 milligram hours of radium element.

The results recorded in this report include 98 cases of the last two 5 year series from May 15, 1925, to May 15, 1927. The complete statistics of the 5 year end-results of all cases of carcinoma of the cervix uteri treated at the Woman's Hospital from February 25, 1919, to May 15, 1927, or a total of eight series, is shown in the following tables. This includes the 14 patients who were refused radium treatment because the growth was too far advanced.

TABLE I.—CASES OF CARCINOMA OF CERVIX SUITABLE FOR RADIUM THERAPY

	Number	Per cent of total
Total cases seen	357	100.0
Cases treated with radium	343	96.1
Cases refused radium	14	3.9

Radium operability—96.1 per cent.

Table II shows that 21.6 per cent of the total number of cases were operable (limited to the cervix) whereas 78.4 per cent were inoperable (extended beyond the cervix).

TABLE II.—OPERABILITY IN CASES OF CARCINOMA OF CERVIX

	Number	Per cent of total
Total	357	100.0
Operable—limited to cervix	77	21.6
Class I Schmitz } Stage I LN	4	1.1
Class II Schmitz } Stage I LN	73	20.5
Inoperable—extended beyond cervix	280	78.4
Class III Schmitz Stages II & III..LN	249	69.7
Class IV Schmitz Stage IV.....LN	31	8.7

TABLE III.—AGES OF CARCINOMA OF CERVIX PATIENTS

Years	Number	Per cent of total
20 to 29 years	18	5.0
30 to 39	71	19.9
40 to 49	121	33.9
50 to 59	94	26.3
60 to 69	40	11.2
70 to 79	12	3.4
80 to 89	1	.3
	357	100.0

Youngest 24 years
Oldest 80 years
Five per cent of the patients were under 30 years of age

TABLE IV.—PRIMARY MORTALITY OF RADIUM TREATMENT FOR CARCINOMA OF CERVIX

	Radium applications	Deaths	Deaths per 100 applications
Total	567	6	1.1
Class I Schmitz } Stage I LN	5	0	0
Class II Schmitz } Stage I LN	126	0	0
Class III Schmitz Stages II & III LN.	409	3	.7
Class IV Schmitz Stage IV LN	27	3	11.1

The primary mortality for all cases treated was 1.1 per cent with no deaths in the Class I or Class II (Schmitz Class) (League Nations Stage I cases).

TABLE V.—CARCINOMA OF CERVIX FOLLOWING SUPRAVAGINAL HYSTERECTOMY

Derived from total of 357 cases

Number	19
Living 5 years	8
Per cent	42.11

TABLE VI.—FIVE YEAR END-RESULTS IN CASES TREATED FOR CARCINOMA OF CERVIX

Grouped according to Schmitz Classification of Extent of Disease

Class	Number	Living	Per cent living 5 years
I	4	2	50.0
II	73	36	49.3
III	249	47	18.9
IV	17	0	0
Total	343	85	24.8

TABLE VII.—FIVE YEAR END-RESULTS IN PATIENTS TREATED FOR CARCINOMA OF CERVIX

Grouped according to League of Nations Classification of Extent of Disease

Stage	Number	Living	Per cent living 5 years
I	77	38	49.4
II	131	33	25.2
III	118	14	11.9
IV	17	0	0
Total	343	85	24.8

Table VII shows that 49.4 per cent of the cases falling into the League of Nations Stage I were saved for at least 5 years, 25.2 per cent of the Stage II cases received 5 year cures; 11.9 per cent of the Stage III cases lived for 5 years after the first radium treatment. None of the Stage IV cases survived the 5 year period.

TABLE VIII.—FIVE YEAR END-RESULTS IN PATIENTS TREATED FOR CARCINOMA OF CERVIX

Comparison between League of Nations and Schmitz Classifications

Classification		Number	Living	Per cent living 5 years
League of Nations	Schmitz			
I	I & II	77	38	49.4
II & III	III	249	47	18.9
IV	IV	17	0	0

TABLE IX.—FIVE YEAR END-RESULTS IN CARCINOMA OF CERVIX TREATED BY UNIFORM WOMAN'S HOSPITAL RADIUM TECHNIQUE

Does not include patients with previous or subsequent treatment or operation elsewhere, or patients treated previous to May 1920, when method was unstandardized

	Number treated	Living	Per cent living 5 years
Total	255	62	24.3
Classes I and II Schmitz Stage I LN Limited to cervix	46	24	52.2
Classes III & IV Schmitz Stages II, III, IV LN Extended beyond cervix	209	38	18.2

From Table IX one notes that 52.2 per cent of the Class I and II (League Nations Stage I) early cases are salvaged for 5 years by the Woman's Hospital technique; 18.2 per cent of the Class III and IV Schmitz (League of Nations Stages II, III, and IV), the inoperable patients were saved for 5 years or more.

TABLE X.—FINAL SUMMARY OF FIVE YEAR END-RESULTS IN PATIENTS WITH CARCINOMA OF CERVIX

		Living	Per cent living 5 years
Total seen	357	85	23.8 "absolute cure"
Total treated	343	85	24.8 "relative cure"

Eleven cases were lost in the follow-up and have been recorded as dead of cancer.
Completed follow-up—96.9 per cent.

TABLE XI.—CARCINOMA OF CERVIX UTERI TREATED BY WOMAN'S HOSPITAL TECHNIQUE, MAY, 1920—MAY 15, 1927, GROUPED ACCORDING TO CELL TYPE

	Number	Per cent of total
Total treated	262	100.0
Squamous I	58	22.1
Squamous I and II	25	9.5
Squamous II	70	26.7
Squamous II and III	19	7.3
Squamous III	24	9.2
Squamous I and III	10	3.8
Adenocarcinoma	22	8.4
Adenocarcinoma and squamous II	1	0.4
Unclassified	33	12.6

An attempt has been made, as seen in Table XI, to group the cases of carcinoma of the cervix according to the type of cancer cell found on microscopical examination. In this series 91 per cent were epidermoid or squamous cell type.

TABLE XII.—FIVE YEAR END-RESULTS IN CARCINOMA OF THE CERVIX UTERI TREATED BY THE WOMAN'S HOSPITAL TECHNIQUE, MAY, 1920—MAY 15, 1927, GROUPED ACCORDING TO CELL TYPE

	Number	Living	Per cent living 5 years
Total treated	262	65	24.8*
Squamous I	58	17	29.3
Squamous I and II	25	3	12.0
Squamous II	70	24	34.3
Squamous II and III	19	0	00.0
Squamous	24	3	12.5
Squamous I and III	10	0	00.0
Adenocarcinoma	22	8	36.4
Adenocarcinoma and squamous II	1	1	100.0
Unclassified	33	9	26.4

*Relative cure rate.

The highest cure rate for any one group was 36.4 per cent for the adenocarcinomata of the cervix. In this group, 8 of the 22 patients survived at least 5 years. This finding is contrary to the

TABLE XIII.—FIVE YEAR END-RESULTS OF CASES OF CARCINOMA OF THE CERVIX UTERI TREATED AT WOMAN'S HOSPITAL, MAY, 1920—MAY 15, 1927, WOMAN'S HOSPITAL TECHNIQUE, GROUPED ACCORDING TO CELL TYPE AND EXTENT OF DISEASE (SCHMITZ CLASS)

	Class I Schmitz	Class II Schmitz	Class III Schmitz	Class IV Schmitz	Total cures
Squamous	0.0% 0 of 1	61.5% 8 of 13	21.4% 9 of 42	0.0% 0 of 2	29.3% 17 of 58
Squamous I and II	..... No cases	25.0% 1 of 4	10.5% 2 of 19	0.0% 0 of 2	12.0% 3 of 25
Squamous II	100.0% 1 of 1	54.5% 6 of 11	29.8% 17 of 57	0.0% 0 of 2	34.3% 24 of 71
Squamous II and III	..... No cases	0.0% 0 of 1			
Squamous III	..... No cases	0.0% 0 of 1	13.6% 3 of 22	0.0% 0 of 1	12.5% 3 of 24
Squamous I and III	..... No cases	..... No cases	0.0% 0 of 9	0.0% 0 of 1	0.0% 0 of 10
Adenocarcinoma	..... No cases	71.4% 5 of 7	25.0% 3 of 12	0.0% 0 of 3	36.4% 8 of 22
Adenocarcinoma and squamous II	..... No cases	..... No cases	100.0% 1 of 1	..... No cases	100.0% 1 of 1
Reclassified	..... No cases	75.0% 3 of 4	22.2% 6 of 27	0.0% 0 of 3	26.4% 9 of 34
Total cures	50.0% 1 of 2	52.3% 23 of 44	20.3% 41 of 202	0.0% 0 of 14	24.8% 65 of 262

general belief that adenocarcinomata of the cervix are more difficult to cure than the squamous cell carcinomata. The next best cure rate was 34.3 per cent for the squamous II type, and thirdly came the squamous I type with a 5 year cure rate of 29.3 per cent. Only 3 of the 24 patients, or 12.5 per cent of those showing squamous III cells survived for 5 years. It is interesting to note the exceptionally low cure rates for those cases which showed a combination of two types of cells. Only 12 per cent of the squamous I and II, none of the squamous II and III, and none of the squamous I and III types lived for 5 years. The 5 year cure rate for the unclassified group was 26.4 per cent. This is approximately what one would expect since it is almost the same percentage as the rate of cure for all cases.

Cure rate for all cases.....24.8 per cent
Cure rate for unclassified group....26.4 per cent

There were 33 cases in the unclassified group, out of which 9 lived for 5 years or more. In 3 of these 9 cases the specimen obtained was too small to examine. One specimen was lost, 2 specimens were so atypical that no diagnosis could be rendered, and in 3 cases no biopsies were taken.

Table XIII was made in an attempt to show the relation of cell type extent of disease, and its bearing upon prognosis. While the groups are very small and general statements are hard to substantiate, nevertheless it can be said that the more extensive the disease and the more malignant and radioresistant the cell type, the worse the prognosis. Adenocarcinoma of the cervix, in this series, gave the best results and therefore the best prognosis. Of the squamous cell carcinomata the squamous II type affords the best prognosis, squamous I affords the next best prognosis, and squamous III gives the worst prognosis. Also, one sees that the further advanced the lesion has extended, the worse the prognosis. Class I and II have a considerably better prognosis than Class II and IV.

SUMMARY

During thirteen years at the Woman's Hospital we have demonstrated that in a gynecological clinic with approximately 280 milligrams of radium element, nearly 25 per cent of those treated for carcinoma of the cervix can be saved for a period of 5 years or longer.

We believe that careful preparation and after care of these patients, with a meticulous personal follow-up clinic, and the employment of re-radiations for early manifestations of recurrence in the vaginal tract will materially increase the percentage of patients salvaged for five years.

A 50 per cent or better absolute cure rate with no radium mortality should be attainable in patients with the disease in its early stages.

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FIVE YEAR "CURES" IN CANCER OF THE BREAST

BURTON J. LEE, M.D., F.A.C.S., NEW YORK

THE object of this meeting is to present to the medical profession and the public, concrete facts dealing with the cures of patients who have been treated for various forms of cancer. It is highly desirable that we, as medical men, should stress the optimistic side of the cancer problem. The public at large, and many doctors, apparently believe that no case of cancer is ever cured. With such a pessimistic attitude of mind nothing can be achieved in any field of human endeavor, and there is no affliction to which mankind is subject where pessimism is more disastrous, or optimism more useful, than in cancer. I feel that it is unfortunate that cancer has been referred to as the great scourge for it is just as respectable a disease as any other disease with which I am familiar, and many patients treated correctly are cured of their ills permanently.

I have been asked to present to you a brief statement concerning the absolute number of 5 year cures at The Memorial Hospital for Cancer and Allied Diseases in patients treated for cancer of the breast by radical surgery combined with pre-operative and postoperative irradiation. I have been told that percentage figures are not desired, but that the absolute number of 5 year cancer cures in my own experience should be given. I have under personal supervision at the present time 90 patients who were operated on for cancer of the breast 5 or more years ago. In all of these patients histological verification of the diagnosis of cancer was obtained and today they are entirely free from disease and constitute healthy, useful, happy members of the society in which they find themselves. Several patients whom I have followed for still longer periods see me annually for a follow-up visit, always terming this yearly call our "anniversary."

I feel certain that this group of 90 women is as useful and happy as any other 90 individuals you can meet in perfect health. But how has this been accomplished? These women came for treatment at an early stage of the disease when one could reasonably hope for a complete cure of their ailment by a combination of surgery and irradiation.

The main reason why all of us do not have still larger numbers of these 5 year cured patients is because many women will persist in not consulting a doctor at frequent intervals, and will not adopt the plan of a careful, complete physical examination by their doctor every 6 months. Moreover, they will not seek the advice of a physician the moment any abnormal symptom referable to the breast appears. The other equally potent reason why more women are not permitted to enjoy this same state of a 5 year cure is that not infrequently doctors in their lack of wisdom assure patients that painless lumps in the breast are of no importance and have no serious import.

CARCINOMA OF THE BREAST

Surgical Treatment, and Results Five, Ten, and Fifteen Years after Radical Amputation

STUART W. HARRINGTON, M.D., F.A.C.S., Rochester, Minnesota
Division of Surgery, The Mayo Clinic

THE surgical treatment of carcinoma of the mammary gland is based on the hypothesis that malignancy is localized at the onset and later in the course of the disease involves other tissues by way of the lymph, and occasionally the blood stream. If this conception of the disease is correct, it is manifest that the most important considerations in treatment are early recognition and immediate complete removal of the growth. The most important factors which influence the results of surgical treatment are the extent of the involvement at the time of operation, the thoroughness with which radical operation is done, and the degree of malignancy as shown by microscopic examination. The following surgical statistics and results of operation are based on a series of 2,257 cases in which operation was performed between 1910 and 1927, inclusive; this permits the compilation of results over a period of 5 years in all cases.

Recognition of malignant disease of the breast by clinical signs and symptoms depends on the duration of the lesion at the time of examination; these signs and symptoms are hopelessly inadequate in determining early malignant disease. If sufficient time is permitted to elapse, it is probable that 100 per cent of these conditions could be diagnosed clinically, but meanwhile much valuable time has been lost before treatment is instituted, and in most instances the patient will have lost any possibility of obtaining permanent cure from surgical treatment.

Fixation of the skin over the tumor is the most characteristic clinical sign of malignant disease; it was noted in 82 per cent of cases. In studying this group with reference to the presence or absence of lymphatic involvement, it was found that in 72 per cent there was metastasis to the regional lymph nodes, which indicates that if fixation of the skin has occurred, metastasis will have occurred in approximately three-fourths of the cases.

Malignant growths are rarely painful in the early stages of the disease, which is one of the chief reasons why patients with malignant disease, in all stations of life, delay examination. In many instances they do not come for treatment until the lesion has ulcerated, as was shown in 7.9 per cent of cases of ulcerated lesions operated on in 1930. This high percentage of cases in which an ulcerating lesion was present at the time of operation again emphasizes the fact that the patients are being seen late in the course of the disease, and also emphasizes the necessity of more earnest educational propaganda.

I do not believe that the presence or absence of metastasis to lymph nodes can be definitely ascertained on clinical examination in all cases. In the cases observed in the last year, palpable nodes were found in 60 per cent and in 68 per cent of this 60 per cent definite axillary metastasis was found at the time of operation. In the remaining cases the enlarged nodes were found to be inflammatory. In the 40 per cent of cases in which enlargement of axillary nodes was not palpable, axillary metastasis was found in 29 per cent. In most cases these enlarged nodes were under the pectoral muscles along the axillary vein. In view of the frequency with which these palpable nodes are found to be inflammatory on microscopic examination, I do not believe it is justifiable to refuse operation. In a review of cases of malignant tumor of the breast encountered from 1910 to 1930, I have tabulated the percentage of cases in which there was nodal involvement at the time of operation. It was found that the average percentage of patients who had nodal involvement in this entire period was 64.2, and that the percentage was little different among cases encountered in the last 10 years. In 1930 the percentage was 62.4. This again indicates that cases are being seen too late in the course of the disease to expect the best results from surgical treatment.

From a surgical standpoint, the cases of lesion of the breast which require most careful consideration are those in which a definite diagnosis cannot be made clinically, and in which the question arises of whether it is best to keep the patient under observation or to treat the condition surgically. In all cases in which there is a single localized tumor, without definite clinical signs of malignant disease, the only safe way to establish a definite diagnosis is by surgical removal of the tumor for microscopic examination. The tumor should be removed by wide excision, well away

from the limits of the growth, and without trauma to the lesion. Usually I prefer to remove a wedge-shaped piece of tissue, including the tumor. Microscopic examination of the tumor should be made immediately after its removal, before the wound is closed. If the tumor proves to be malignant the operation should be completed as a radical amputation.

I do not believe that it is ever justifiable to remove any growth from the breast without immediate microscopic examination of frozen sections of the tissue, and the manner of completing the operation is indicated by examination of the tissue; the poorest surgical results in carcinoma of the breast are obtained from secondary radical amputation after primary partial removal of the tumor. In a review of the series mentioned, I found that 11 per cent of the patients had undergone a primary, minor operative procedure and in these cases, I performed secondary radical amputation. In this group lymphatic involvement had occurred in 79 per cent of cases, as compared with 64 per cent of cases in which primary radical operation had been performed. The results of radical secondary amputation are correspondingly less satisfactory than after primary radical amputation. These cases, in which a primary minor operation had been done, do not give a correct impression of the results because in approximately 50 per cent of them operation could not be done; the condition was hopelessly inoperable at the time the patients presented themselves at the clinic. This is particularly true when some type of escharotic paste had been used on the breast primarily, for in more than 80 per cent of these, the condition is inoperable.

The best surgical results are obtained by primary radical amputation. In this series of 2,257 cases in which operation was performed between 1910 and 1926 the cases were divided into groups depending on whether there was nodal involvement. In the series without nodal involvement, 71.2 per cent of the patients are living 5 years after operation, 52.9 per cent are living 10 years, and 40.7 per cent 15 years after operation. In the cases in which there is involvement of nodes the results are not as satisfactory, but probably are more favorable than when there is metastatic malignancy from growths elsewhere in the body. In the group of patients with nodal involvement, 26.3 per cent are living 5 years after operation, 14.6 per cent 10 years after operation, and 10.5 per cent 15 years.

The technique of the radical operative procedure has been fairly well standardized. I do not make a uniform type of incision in the skin, for I believe that the best results are obtained when the incision is planned in each case so as to remove the greatest amount of skin over the diseased portion and leave the least deformity and restriction of motion of the arm. If the incision is properly planned in accordance with the situation of the tumor, sufficient skin can be removed so that there is little danger of local recurrence, and skin grafting is rarely necessary except in the most extensive cases. In a general way, if the tumor is in the upper or lower quadrant of the breast, a vertical incision will give the best results in completely removing the growth, and in giving adequate exposure for deep dissection. If the growth is in the extreme inner or outer quadrant of the breast a transverse incision is usually best. After the cutaneous incisions have been outlined, dissection of the subcutaneous tissue is made around the entire operative field, the median portion of the dissection being carried to the median line of the body, the lateral portion to the border of the latissimus dorsi muscle, extending below over the upper portion of the rectus fascia and above to the clavicle. Approximately two-thirds of the clavicular portion of the pectoralis major muscle is then divided and its attachment severed from the humerus. The lymph nodes along the upper portion of the brachial vessels are then thoroughly removed and the dissection is carried to the lower border of the pectoralis minor muscle. The attachment of this muscle to the coracoid process of the scapula is then severed. The dissection of the axillary and sternal lymph nodes is entirely completed, all of the nodes that lie along the lateral thoracic wall and in the axilla being removed, both above and below the axillary vessels, to the point where the axillary becomes the subclavian vein. The branches of the axillary vessels are caught and ligated as the dissection of the lymph nodes proceeds toward the sternum, the long thoracic and subscapular nerves being preserved. This completely outlines the tissues to be removed which are still attached to the thoracic wall, and which consist of the breast, the subcutaneous tissue, the axillary nodes and node-bearing fascia, the pectoralis minor muscle, and the greater portion of the pectoralis major muscle. These structures are then dissected from the thoracic wall, starting from the lateral aspect, ligating the perforating intercostal vessels. The anterior sheath of the rectus muscle is removed as the dissection proceeds toward the median line and all the carcinoma bearing tissue is removed in one mass.

The results of radical operation depend, to a great extent, on the thoroughness with which the

TABLE I.—RADICAL AMPUTATION FOR CARCINOMA OF THE BREAST

(5 and 10 Year Results According to the Grade of Malignancy in 1,911 Cases in Which Operation Was Performed from 1910 to 1927 Inclusive)

Grade of malignancy	Cases	Per cent of total cases	Patients living, per cent of cases in grade	
			5 years	10 years
Involvement of lymph nodes				
1	11	0.7	100.0	80.0
2	121	7.9	49.1	38.1
3	530	34.5	26.9	10.3
4	873	56.9	19.4	11.3
Total	1535	80.3	25.0	13.7
No involvement of lymph nodes				
1	41	10.9	93.1	83.3
2	96	25.5	76.4	43.7
3	128	34.0	61.8	46.9
4	111	29.5	55.4	38.8
Total	376	19.7	66.4	49.0

operative procedure is performed. I do not think the importance of this can be overestimated, inasmuch as the only possibility of obtaining cure from surgical treatment is from the original operative procedure; it has been my experience that secondary operative procedures have been of little benefit.

In cases in which a definite clinical diagnosis of malignant disease can be made, the condition usually is fairly well advanced and the decision as to the type of treatment to be instituted depends on the amount of involvement present. In cases in which the lesion is unilateral, and clinical examination does not reveal evidence of distant metastasis, primary radical amputation should be performed. In certain cases in which the supraclavicular nodes are palpable, radical amputation may be performed because of the possibility that the nodes are inflammatory. In such cases it is best to apply radium to the nodes subsequent to operation because of the possibility that they may harbor metastatic growths. I do not believe that operation is advisable if clinical examination demonstrates definite distant metastasis to the lungs, bones, or liver. If there is an extensive ulcerating lesion, and a possibility of removing the ulcerated portion and closing the skin, I believe radical amputation should be performed, rather than a more palliative procedure, such as a simple amputation. There is very little additional risk in radical amputation as compared with simple amputation, and in cases of the kind mentioned, radical operation is in reality palliative. I believe that the prognosis is much better when radical operation is performed.

The most valuable indications as to prognosis in cases of carcinoma of the breast are obtained by study of the grade of malignancy present and by determining the extent of the disease as indicated by the absence or presence of lymphatic involvement. We are now making a study of the grades of malignancy in all cases of carcinoma of the breast in which operation has been performed since 1910. This study has not been completed, but the results are known in 1,911 of the cases in which operation was performed from 1910 to 1927 inclusive, and this, I believe is a sufficient number to permit a preliminary report. The results of this study are uniform throughout in that the results of operation in the presence of lower grades of malignancy were much better than in the presence of higher grades, and the results in cases in which nodal involvement was absent were uniformly better in all grades than in cases in which nodal involvement was present. The results of this study are shown in Table I.

The results in those cases in which postoperative roentgen treatment had been given and those in which it had not been given were compared. In the cases in which there was lymphatic involvement and roentgen treatment had been given, the average proportion of patients with lesions graded 3 or 4, who were living after 3 and 5 years, was 4.8 per cent more than among a similar group, who had not had roentgen treatment, and the average proportion of patients with lesions graded 1, 2, 3 or 4, who were living after 10 years, was 4.2 per cent less than among a similar group who had not had roentgen treatment. The proportion of patients living after 3 or 5 years, whose lesions were graded 1 or 2, was 2 per cent less than in a similar group who had had roentgen treatment. These results indicate that postoperative roentgen treatment may be of benefit for highly malignant lesions, particularly if there is lymphatic involvement, but it should not be used as a routine measure, since the results are less satisfactory when it is used for lesions of lower grades of malignancy, and if the results after 10 years are considered, they appear to be less satisfactory when lesions are of the higher grades of malignancy. I believe that roentgen treatment is of benefit in selected cases but in certain other cases it may be detrimental. If severe reaction follows, its use should be discontinued. I have seen a number of cases of this

type in which distant metastasis occurred earlier than would have been expected from the degree and extent of the malignancy found at the time of operation. Because of lack of uniformity of results in treating the different grades of malignancy, and because there was no marked variation in the results obtained, whether or not roentgen rays were used, I believe the practical importance of this study is that patients who are accepted for surgical treatment should have as radical and thorough an operative procedure as possible, since roentgen rays cannot be depended on to remove any malignant tissue that may be left as a result of incomplete operation.

CONCLUSIONS

1. Present clinical methods are inadequate to detect malignancy until it is fairly well advanced.

2. Microscopic examination should be made in all doubtful cases, and this should be followed immediately by radical operation if the lesion proves to be malignant.

3. The best surgical results are obtained from primary radical amputation in cases in which there is no involvement of lymph nodes. In cases of this type reviewed 71.2 per cent of patients were living 5 years after operation, 52.9 per cent were living 10 years after operation and 40.7 per cent were living 15 years after operation. In the cases in which there is involvement of lymph nodes the results are not as satisfactory but probably more favorable than those obtained when there are metastatic growths elsewhere in the body. In cases of this type reviewed, 26.3 per cent of patients were living 5 years after operation, 14.6 per cent were living 10 years after operation, and 10.5 per cent were living 15 years after operation.

4. The surgical results are not as satisfactory in cases in which secondary radical amputation is done following a previous primary partial operative procedure.

5. The most important indications as to prognosis were the degree of malignancy and the presence or absence of involvement of nodes.

6. Surgical results are more satisfactory in the presence of lower grades of malignancy.

7. Postoperative roentgen therapy is not a definite auxiliary to surgical treatment. In selected cases in which the grade of malignancy is high it may be of value, but it is of no benefit if the grade of malignancy is low.

PROGNOSIS IN GASTRIC CARCINOMA TREATED BY RESECTION

GATEWOOD, M.D., F.A.C.S., CHICAGO
From the Department of Surgery, Presbyterian Hospital of Chicago, and Rush Medical College, University of Chicago

ANALYZING the histories of all of the cases of carcinoma of the stomach entering the Presbyterian Hospital between January 1, 1920, and December 31, 1929 (1), I found that, where sufficient data were obtainable, the patients waited an average of 5.3 months before seeing a doctor and that a further delay of 8.3 months occurred before these patients came to operation! The reasons for the delays are numerous, the most common being the fact that the patient had had some previous stomach trouble. However, lack of careful examination of the patient was very often a cause and the responsibility rested squarely with the physician. A third, which was present all too frequently, was the fact that many physicians still feel that the patient

	I	II	III	IV	V	VI	VII
Hospital number	86245	89102	135854	210790	143163	159664	163855
Sex and age	F 48	M 64	M 51	M 31	M 45	M 65	M 62
Date of operation	5–20–15	9–13–15	9–1–20	11–27–20	3–3–22	9–13–22	2–3–23
Duration of symptoms	1 yr.	2 mos.	12 yrs.	3 mos.	8 yrs.	8 mos.	3 mos.
Chief symptoms in order of occurrence							
Pain	5	2	3	2	1	4	1
Weakness	1	—	2	1	—	—	2
Indigestion	—	1	1	—	—	—	—
Fullness	3	—	—	—	—	—	—
Loss of appetite	4	3	—	1	—	—	3
Loss of weight	25 lbs.	—	5 lb. gain	—	12 lb. gain	20 lbs.	—
Vomiting	—	—	—	3	2	—	—
Knowledge of tumor	—	—	—	—	—	1	—
Hæmorrhage	—	—	—	—	3	3	—
Anæmia	—	—	—	—	—	—	—
Diarrhœa	—	—	—	—	—	2	—
Ulcer history	No	—	12 yrs.	—	8 yrs.	—	No
Physical examination							
Emaciation	—	—	Yes	Yes	No	Yes	Yes
Glands	No	No	No	No	No	Inguinal	No
Tumor	Yes	Bulging	No	No	No	Yes	Yes
Peristalsis	No	Yes	No	—	Yes	—	—
Tenderness	Yes	—	Yes	No	Yes	Yes	Yes
Laboratory							
Hæmoglobin	70	82	85	50	79	45	55
Retention	No	Yes	Yes	No	Yes	Yes	Yes
Acidity							
Free	0	0	18	30	25	0	0
Total	0	44	42	60	40	17	18
Lactic	—	—	—	—	—	—	—
X-Ray							
Obstruction	No	—	—	—	Yes	—	No
Site	Pylorus and pars media	—	End of antrum	End of antrum	Antrum near pylorus	Fundus	Antrum Less curv.
Operative findings							
Pylorus	—	Mass	Mass	Mass	—	—	—
Lesser curvature	—	—	—	—	Mass & ulcer	—	—
Pars media	—	—	—	—	—	—	—
Greater curvature	Mass	—	—	—	—	Mass	—
Fundus	—	—	—	—	—	—	Mass
Glands	—	Yes	—	—	Yes	—	—
Fluid	—	—	—	—	—	—	—
Pathology							
Microscopic	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma	Papillary cystic carcinoma	Scirrhus adenocarcinoma	Adenocarcinoma	Ulcer carcinoma
Subsequent history	Living 17 yrs. Recurrence	Dead 16½ yrs. Recurrence	Living 12 yrs. Well	Dead 9 yrs. Recurrence	Dead 5 yrs. Recurrence	Living 10 yrs. Well	Living 9 yrs. Well

is hopelessly doomed from the start and that operative interference carries a high mortality with little or no relief.

On account of such notions in the minds of many physicians and patients, it has been deemed worth while to report those cases of proved carcinoma which have survived longer than 5 years. During the 10-year period 417 cases were discharged with the diagnosis of carcinoma of the stomach. Almost exactly one-half, or 208, of these were either inoperable at the time they were seen or refused operation. While it must be admitted that some of these patients had very few symptoms before they were considered inoperable, the majority of them were the victims of procrastination. According to most postmortem statistics (2), three-fifths of gastric cancers occur at or near the pylorus and should give symptoms relatively early. Only about one-fifth are in the cardiac portion and beyond the range of operability from the outset. Of the 209 cases which were operated upon, 30 per cent were found to be so extensive that the operation was purely exploratory. Fifty-eight resections were done. The operative mortality has been materially reduced in the last few years by more careful preparation of the patients, and while it still seems high (about 18 per cent) it is only a trifle higher than for gastro-enteros-

VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII
166706	170843	173972	176107	175146	185401	188498	210131	238414	217787
M 57	M 50	M 58	F 56	M 52	M 49	F 73	M 69	M 41	F 39
5-16-23	9-25-23	1-19-24	3-20-24	4-30-24	1-22-25	5-6-25	3-29-27	5-9-27	11-3-27
18 mos.	3 mos.	5 mos.	8 yrs.	5 mos.	13 mos.	2 yrs.	2 yrs.	4 yrs.	10 mos.
1	—	—	—	1	1	—	1	1	1
3	—	1	—	5	4	3	2	—	—
—	—	—	2	—	—	1	—	—	—
—	—	2	1	2	—	—	—	—	—
—	—	—	—	—	3	—	—	—	—
42 lbs.	35 lbs.	—	—	30 lbs.	42 lbs.	20 lbs.	37 lbs.	3+lbs.	30 lbs.
4	—	—	4	—	6	—	4	—	—
—	—	—	—	—	5	—	—	—	1
—	—	—	—	3	—	—	3	2	—
—	—	—	—	6	2	4	—	—	—
—	1	—	—	—	—	—	—	—	—
No	No	6 mo.	No	No	15 yrs.	No	Yes	Yes	—
Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes
Inguinal	No	No	No	—	No	No	No	No	No
Yes	No	Yes	Yes	Yes	Bulging	Yes	No	No	Yes
Yes	—	No	No	Yes	Yes	No	No	No	—
Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes
82	80	37	89	46	58	65	90	—	33
Yes	—	Yes	Yes	Yes	—	—	Yes	Yes	—
42	0	0	—	0	18	—	23	Much	0
61	34	30	—	11	26	—	39	free acid	35
—	—	—	—	0	—	—	—	—	—
—	—	—	—	Yes	Yes	No	Yes	No	—
Central third	—	—	—	Pylorus	Pylorus	Central portion	Pylorus	Pylorus	Lower half
—	—	—	Mass	Mass	Mass	—	—	Mass & ulcer	Involved
—	Mass	Mass	—	—	—	—	Mass & ulcer	—	Mass
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
Mass	—	—	—	—	—	Mass	—	—	—
Yes	—	No	—	—	Yes	—	Yes	—	No
—	—	—	—	Yes	—	—	—	—	—
Diffuse scirrhus carcinoma	Scirrhus carcinoma (carcinoma simplex)	Adenocarcinoma	Adenocarcinoma	Papillary adenocarcinoma	Adenocarcinoma	Papillary adenocarcinoma	Adenocarcinoma	Ulcer carcinoma	Colloid carcinoma
Dead 6 yrs. Recurrence	Dead 5½ yrs. Recurrence	Dead 5 yrs. Recurrence	Living 8 yrs. Well	Living 8 yrs. Well	Dead 5 yrs. Postoperative pneumonia autopsy: no carcinoma	Living 7 yrs. Well	Living 5 yrs. Well	Living 5 yrs. Well	Living 5 yrs. Well

tomy in cancer cases. The operation of choice has been wide resection of the mass together with all adjacent glands, followed by Billroth II closure, or some modification of it such as the Polya or Balfour.

Of those patients who survived operation, 46.1 per cent lived over 3 years, and 39.5 per cent have survived over 5 years, 1 patient being alive and well at the end of 12 years. In addition to this group, 2 other patients have been observed during this period, who were operated upon in 1915, surviving 16 and 17 years. Although a 5 year survival is by no means a criterion of a cure and recurrence may occur even after 15 years, the amount of relief and comfort to these patients has been enormous, especially when compared to the hopeless picture of medical management or the palliative operation of gastro-enterostomy. Following are brief abstracts of the histories of the patients operated upon prior to 1928, who have survived at least 5 years.

CONCLUSIONS

The terrific mortality from carcinoma of the stomach can be lowered by more careful work on the part of medical men and by judicious propaganda.

Seventeen cases of gastric carcinoma surviving the five-year period are recorded.

Wide resection carries very little more mortality than palliative operations and in this series, 40 per cent of the patients who recovered from operation have survived more than 5 years (100 per cent follow-up).

Barring the discovery of some real cancer cure, our efforts must be directed to earlier diagnosis and prompt radical resection which will improve very greatly the outlook in this all too common carcinoma.

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MALIGNANT TUMORS OF THE KIDNEY AND PELVIS OF THE KIDNEY

Five Year Cures Following Nephrectomy with Partial or Complete Ureterectomy

WALTMAN WALTERS, M.D., F.A.C.S., Rochester, Minnesota
Division of Surgery, The Mayo Clinic

FOLLOWING surgical removal of malignant tumors of the kidney at The Mayo Clinic, from 1901 to January, 1927, 110 patients have lived for 5 or more years. Inasmuch as malignant renal tumors were removed from 256 patients during this period, there have been cures for 5 years or more in approximately 43 per cent (42.99), of these cases. Of further interest is the fact that 68 of the 110 patients have lived from 5 to 10 years; 22 have lived 10 years or more; 15 have lived from 15 to 20 years; and 5 have lived more than 20 years (Table I). Although the purpose of this paper is primarily to report the number of patients surviving longer than 5 years after the removal of malignant tumors, the fact must not be lost sight of that among those patients who lived less than 5 years, the surgical treatment directed toward the eradication of the disease undoubtedly prolonged the patients' lives and made life more comfortable.

In 41 additional cases, the malignant tumor of the kidney was so extensive, as determined by incision and exploration of the tumor, that the lesion could not be removed and after specimens were taken from the tumor for microscopic examination, roentgen rays and radium treatment was instituted. Seven (17 per cent) of these 41 patients who had inoperable malignant renal tumors lived for more than 5 years (Table II). This group of 41 inoperable cases might well serve as a control group in evaluating the benefits of surgical removal of malignant renal tumors, and emphasis might be placed on the fact that in the group of operable cases, in which the tumors were removed, the percentage of 5 year cures was 43, whereas among those cases in which the lesion could not be removed surgically because of its extent, even though the tumor was treated extensively by roentgen rays and radium, only 17 per cent of the patients lived more than 5 years subsequent to the beginning of such treatment. I should like, however, to give full credit to the apparent benefits of postoperative use of roentgen rays and radium applied over the former site of the malignant lesion as an adjunct to surgical treatment of these lesions. For many years, it has been a routine to give courses of roentgen rays and radium immediately following recovery of patients from removal of malignant renal tumors, and in the group of 110 cases of 5 year cures, postoperative application of either roentgen rays or radium has been carried out in 33 cases. Roentgen therapy has been of further value in some cases in which highly malignant tumors appeared to have undergone fixation and therefore to be inoperable; in some cases, that is, after a course of roentgen therapy, the tumor decreased in size and became more mobile, enabling nephrectomy, with removal of the tumor, to be accomplished successfully.

PATIENTS LIVING

It would seem that following removal of malignant tumors, if recurrence does not take place within 5 years, one can justly anticipate complete and permanent cure. However, in order to determine accurately whether such a conclusion might be accepted as fundamental, I have followed the progress of the 110 patients mentioned, and have found that 76 of them are living and well, whereas 34 have died. Analysis of the 34 cases in which the patients have died would indicate that recurrence had taken place in 16, metastasis to various tissues as follows: to the bone in 4, to the lungs in 3, and to the brain in 3. Of the 41 cases which I have designated as inoperable in which treatment was by roentgen rays and radium, although 3 patients lived for 5 years, 2 for 18 years and 1 for 15 years, only 1 of the entire series is living at the present time. This would further emphasize the value of surgical removal of malignant renal tumors, and the importance of recognition of such a lesion in its removable stage.

LONGEVITY DEPENDING ON BRODERS' INDEX OF MALIGNANCY

For the last 10 years the grading of malignant tumors has been routine at the clinic, and Broders' index of malignancy has been used. In addition to the grading of the tumors removed during this period at the clinic, Broders and Hand have re-examined grossly and microscopically 193 malignant renal tumors removed between 1901 and 1923, and have graded them on the basis of degrees of cellular differentiation interpreting

TABLE I.—FIVE YEAR CURES IN 256 CASES OF MALIGNANT RENAL TUMORS: NEPHRECTOMY WITH AND WITHOUT PARTIAL OR COMPLETE URETERECTOMY

	Cases	Per cent
Lived 5 or more years	110	43
Had roentgen-ray and radium also	33	..
Lived from 5 to 10 years	68	..
Lived from 10 to 15 years	37	..
Lived 20 years	5	..
Living at present	76	..
Of these patients dead (16 from metastasis)	34	..

their results in relation to prognosis. Quoting from their paper: "The grade of malignancy was found to be higher if patients were less than 40 years of age . . . as the degree of malignancy increased . . . the length of postoperative life decreased. . . . An interesting relation exists between the grade of malignancy of the number of patients dead. Of the patients who have died, many more are found among those who had higher grades of malignancy A larger proportion of those patients living following nephrectomy for malignant renal tumors had carcinomas of lower rather than of higher grade of malignancy. Study of postoperative results in cases of carcinoma of the kidney based on the degree of cellular differentiation in the tumor, represents a distinct advance in knowledge of this disease."

In a study of the grade of malignancy of the 110 malignant renal tumors removed from patients who lived 5 years or longer, it is noted that grades 2 and 3 occurred most frequently and that in 43 cases the grade was 2 and in 21 cases it was 3. Next in order of frequency were tumors of grade 1; 13 cases. In only 4 cases were there 5 year cures among those in which tumors were of grade 4.

Of further interest are the facts that in the group of 110 cases in which there were 5 year cures, 70 per cent of the patients who had tumors of malignancy graded 1 are living at the present time; 67 per cent of those with tumors graded 2; 62 per cent of those with tumors graded 3; and none of those with tumors graded 4. This, further, indicates the accuracy of the method of determining the degree of malignancy and the prognosis in cases of operable malignant renal tumor.

TYPES OF MALIGNANT RENAL TUMOR

Adenocarcinomata or hypernephromata constitute practically all the malignant tumors of the kidney, with the exception of primary, squamous cell epitheliomata of the pelvis of the kidney. The ratio of squamous cell epitheliomata to adenocarcinomata is variously estimated to be 1:11 and 1:14. In the series of 110 cases in which 5 year cures were obtained, hypernephromata or carcinomata existed in 100 of the cases, whereas epitheliomata of the renal pelves were present in 7, and sarcoma in 3.

TABLE II.—INOPERABLE MALIGNANT RENAL TUMORS (41 CASES) EXPLORATION: RADIUM OR ROENTGEN RAY TREATMENT

	Cases	Per cent
Lived 5 or more years	7	17
Lived 5 to 10 years	6	..
Lived 15 years	1	..
Living at present time	1	..
Dead	6	..
From metastasis	4	..
From unknown cause	2	..

Sarcoma of the kidney is relatively rare. In an unselected group of 225 cases of malignant tumors of the kidney in which operation was performed in the clinic, only 10 of the tumors were sarcomata, and in the series of 110 in which 5 year cures were obtained, cases of sarcoma numbered 3. The assumption that sarcoma of the kidney affects chiefly young adults has not been borne out in our experience. For example, 8 of the 10 patients with sarcoma of the kidney were adults, whereas the tumors in a series of 13 children with malignant tumors of the kidney were reported by the pathologist as adenocarcinoma, sarcoma and Wilms' tumor.

SYMPTOMS OF RENAL MALIGNANT TUMORS

The symptoms of lumbar pain, presence of a tumor in the region of the kidney, and hæmaturia occurred individually or collectively in practically all cases of malignant tumors of the kidney. In a group of 367 tumors of the renal cortex reported from the clinic by Judd and Hand, one of these three symptoms was present in 99 per cent of the cases. Hence, early recognition of an abnormal condition of the kidney should not be difficult. That the significance of such symptoms, however, occasionally passes unrecognized is evidenced by the fact that in 192 cases of malignant tumor of the kidney in which nephrectomy was performed, the average duration of symptoms before operation varied from 17 to 21½ months. This delay, it would seem, should not have occurred.

It is probably unnecessary to emphasize the absolute necessity of cystoscopic examination of patients with hæmaturia. In the presence of a history of hæmaturia, the burden of proof that a malignant tumor is not present in the bladder or the kidney lies directly on the examining physician, and the only accurate method of determin-

ing or eliminating the possibilities is by use of cystoscopic examination, and of the other refinements of urological diagnosis, such as intravenous urography or pyelography.

The fact that the duration of life and the completeness of cure are proportionate to the degree of malignancy and the size and extent of the malignant lesion of the kidney should serve as a plea for earlier diagnosis and earlier surgical treatment of this lesion.

CARCINOMA OF THE PROSTATE

HUGH H. YOUNG, M.D., F.A.C.S., F.R.C.S.I., BALTIMORE, MARYLAND
From the James Buchanan Brady Urological Institute, Johns Hopkins Hospital, Baltimore

IN 1904, after a study of postmortem specimens, I devised a radical operation for carcinoma of the prostate, and on April 7, 1904, carried it out on the first patient. The technique of this operation was as follows: The prostate was exposed by the perineum, as in Young's conservative perineal prostatectomy, the tractor having been introduced through an incision in the membranous urethra. After exposure of the posterior surface of the prostate, the diagnosis was confirmed. The operator then proceeded to remove the entire prostate with its capsule and urethra, neck of bladder, lower half of trigone, seminal vesicles, and ampullæ of the vasa deferentia, thus excising in one block the entire carcinomatous area with a large margin of normal tissue. Closure was then effected by anastomosing the bladder to the membranous urethra.

This operation has now been carried out in my clinic in 40 cases. The total mortality has been about 6 per cent, and there is one series of 18 cases with only one death. Had the operation been confined to cases in which the prognosis was good, both the mortality rate and the percentage of recurrences would have been greatly reduced.

At the request of Dr. Martin I have confined this report to those cases in which the operation was performed five years ago, or longer. I find in this category 29 cases. We have made a careful study as to recurrences in 25 patients who left the hospital, and beg leave to report as follows: Seven patients are living and well without recurrence or metastases. The duration since operation has been 5 years in 3 cases; 7 years in 2 cases; 9 years in 1 case; and 18 years in 1 case. Five patients have died without recurrence or metastases. These lived the following periods: 1 patient, 6 years; 2 patients, 7 years; 1 patient, 9 years; 1 patient 13 years. There are, therefore, 12 patients who passed the 5 year period, or 48 per cent cured.

The early patients all had incontinence of urine when on their feet. I believe that this was due to interference with the blood and nerve supply of the external sphincter. I therefore changed the operation. By dissecting beneath the anterior pelvic fascia I found it possible to preserve these, and since then a large percentage of the patients have had complete urinary control.

On account of the marked encapsulation of the prostate by its own capsule and two layers of pelvic fascia, which surround it, carcinoma of the prostate is confined within three fascial coverings and rarely penetrates them until late. As the disease progresses it generally travels upward into the region behind the bladder and in front of the two layers of fascia. Carcinoma of the prostate, therefore, probably presents the best prognosis for a radical cure of any of the deep seated organs, this remarkable encapsulation, confining the disease to the limits of the prostate itself, being the finest safeguard against invasion of adjacent tissue and giving the surgeon a splendid opportunity for a radical cure with the operation here presented, which shows 48 per cent of cures over 5 years.

MALIGNANT TUMORS OF THE BLADDER

A Review of 165 Cases in which the Patients Lived Five Years or More Following Various Surgical Procedures

VIRGIL S. COUNSELLER, M.D., F.A.C.S., WALTMAN WALTERS, M.D., F.A.C.S., Rochester, Minnesota
Division of Surgery, The Mayo Clinic

THE results following various surgical procedures in the treatment of carcinoma of the urinary bladder, although not excellent, are nevertheless gratifying, particularly when it is considered that the average patient with carcinoma of the bladder may not seek treatment until several weeks after the onset of the disease. The high degree of perfection attained by the urologist in diagnosing the type of lesion, its extent, situation, and degree of malignancy, is a distinct aid in determining the type and magnitude of the operation as well as in evaluating the end-results.

At The Mayo Clinic from 1910 to January, 1927, 600 malignant tumors of the bladder were treated by various surgical procedures, consisting of resection, excision, surgical diathermy, combined with ligation and reimplantation of the ureter, transplantation of the ureters to the back with total cystectomy and treatment by radium. In this group of 600 patients, 165 (about 28 per cent) were cured for 5 years or more. One hundred three of the 165 patients have lived from 5 to 10 years; 43 have lived 10 years or more, 14 have lived from 15 to 20 years, and 5 have lived more than 20 years. Sixty-seven (40.6 per cent) of the 165 patients had recurrences although 42 of the 67 are now living and free from symptoms referable to the bladder. The deaths of 19 of the 25 patients were the result of local recurrence or metastasis. One hundred sixteen (70 per cent) of the 165 patients are alive and free from symptoms.

The choice of operation for malignant lesions of the bladder is determined principally on their site, extent, and grade of malignancy. It is known that those situated at the base of the bladder are of a higher grade of malignancy and are of the infiltrating type, usually involving one or both ureters. Those situated in the lateral walls and dome are more amenable to surgical attack and are less malignant. The lesions in 110 (66.66 per cent) of our 165 cases were on the lateral walls and dome, whereas 55 (33.33 per cent) involved the base, trigone, urethra, and ureteral orifices.

Seventy-four of the patients were treated by resection or excision, and of this number 28 (approximately 38 per cent) had recurrences. Fifty patients lived from 5 to 10 years; 17 lived 10 years or more and 7 lived from 15 to 20 years. Resection and excision combined with other surgical procedures were used in treating 70 of the 165 patients, and of this number 33 (47.1 per cent) had recurrence. However, 35 patients lived 5 to 10 years; 25 lived 10 years or more, 6 lived 15 to 20 years, and 4 lived more than 20 years.

Transvesical electrocoagulation (diathermy) was used in treating certain tumors of the bladder, mostly of the infiltrating type confined to the base of the bladder and considered non-resectable. Seventeen of the 165 patients were treated by this method. There were 5 recurrences (29.2 per cent). Sixteen of the 17 patients lived from 5 to 10 years and 1 patient lived more than 10 years. Fifteen (88 per cent) of the 17 patients treated by electrocoagulation are living and are free from symptoms referable to the bladder. If it is considered that the cases were judged to be inoperable, the results indicate that the patients who lived less than 5 years, and who were treated by diathermy undoubtedly lived longer and in greater comfort because of this treatment. It should, therefore, be considered a very effective method of treating not only the more malignant inoperable lesions, but those more favorably situated and less malignant.

Not infrequently palliative cystostomy for extensive malignant lesions of the bladder with the subsequent application of radium is justified. Two patients with such lesions were so treated with surprisingly favorable results. One patient lived 5 years and the other is living more than 15 years.

Total cystectomy with transplantation of the ureters to the back was performed on 2 patients. There has been no recurrence and both patients are living, 1 more than 5 years and the other more than 20 years.

The grade of malignancy was studied in 151 of the 165 cases in which the patients are living 5 years or more. In 14 the malignancy was not graded. In 38 cases the malignancy was graded 1, in 67 it was graded 2, in 30 it was graded 3, and in 16 it was graded 4. It should be noted that 105 (63.63 per cent) of all the malignant tumors were of the less malignant type (grades 1 and 2). Only

69 per cent were graded 4. It is further of interest that in the group of 165 patients living 5 years or more, 76 per cent who had malignant tumors graded 1, 67 per cent of those with tumors graded 2, 66 per cent of those with tumors graded 3 and 62 per cent of those with tumors graded 4 are living at the present time. The relative high percentage of 5 year cures of patients with tumors graded 3 and 4 is striking, but serves to emphasize the importance of treating malignant lesions of the bladder which at first seem inoperable.

A study of the recurrence of tumors according to the grade of malignancy reveals a rather uniform percentage of recurrence of tumors of all grades. In 67 cases the patients survived 5 years or more, but they had definite local recurrences. Of these 67 patients, 15 had recurrent growths graded 1, 12 of whom are living; 33 had recurrent growths, graded 2, 20 of whom are living; 11 had recurrent growths graded 3, 5 of whom are living; and 4 had recurrent growths graded 4, 3 of whom are living. Considering the entire recurring group, 42 patients (62 per cent) have lived from 5 to 10 years; 21 (31 per cent) have lived 10 years or more; 2 (3 per cent) have lived 15 to 20 years; and 2 (3 per cent) have lived more than 20 years.

Postoperative recurrence or extension of the malignant growth takes place, regardless of the method of removal, usually in the form of implants, either before or after operation, or by direct extension beyond the tissue removed or along the lymphatic structures. Since recurrent growths of all grades were noted rather uniformly, it would seem that recurrence would develop in a variable percentage of cases regardless of the degree of malignancy. Recurrence after radical excision or electrocoagulation of a growth of low malignancy is not so likely to occur as it is following the same procedure for a growth graded 3 or 4.

For many years it has been a routine procedure at The Mayo Clinic (introduced by Crenshaw) to request such patients to return in 3 months for a check up on the condition of the bladder, then again in 3 months, then in 6 months and then in 1 year. In this manner many recurrent growths are discovered before symptoms develop, thereby making it possible greatly to improve the end-results. Unfortunately some patients disregard the follow-up note and fail to return until there is extensive local recurrence requiring secondary surgical procedures.

Of the 67 patients who had recurring lesions in the bladder, 36 (53.73 per cent) were treated by transurethral fulguration or by radium. Twenty-six patients (75 per cent) so treated are living and are free from symptoms. Twenty patients (29.85 per cent) of the 67 required secondary surgical procedures by the suprapubic route. Only 8 (4 per cent) are now alive. The condition of 5 patients who did not return for a check up was considered inoperable according to the symptoms as given in correspondence. Only 2 patients (4 per cent) are known to be living. From the correspondence of 6 patients of the group, recurrence was considered doubtful; all of this group are now alive and well for periods of 5 to 15 years after operation.

It is apparent, therefore, that if results of treatment of malignant tumors of the bladder are to be further improved, then there must be a rigid selection of the surgical procedure that should be applied, as determined by the situation, extent, and grade of malignancy of the lesion, together with a rigid follow-up system.

TUMORS OF THE TESTIS

Five Year Cures Following Radical Operation

FRANK HINMAN, A.B., M.D., F.A.C.S., San Francisco, California

THE following presentation is an attempt to ascertain the value, if any, of radical surgery in tumors of the testis and, in order to compare results, certain important characteristics of these tumors with reference to surgical treatment should be recognized and these characteristics may be discussed under the three headings: (1) pathological, (2) clinical, and (3) therapeutic.

Pathological characteristics. The exact pathological nature of testicular tumors remains uncertain. New-growth may arise from any type of cell present in the testis so that connective tissue, epithelial and mixed type tumors are possible. Whatever interpretation is made as to character and origin, it should be well understood that both pathologists and clinicians agree that for practical purposes all tumors are to be regarded as malignant. In the pathological differentiation of these different tumors, there are two outstanding characteristics. In one group is a mixed tumor type of teratoma in which all three germ layers (epiblast, hypoblast, and mesoblast) may be more or less equally represented in a typical tridermal teratoma, or there may be a one-sided overgrowth, first, of the epiblast, forming squamous epithelioma, basal celled carcinoma, chorio-epithelioma or a neuro-epithelioid type tumor, second, of the hypoblast, forming the simpler papillary adenofibromata, adenocarcinomata or cirrhous carcinoma and, third, of the mesoblast, forming cartilagenous, myomatous or mesochondro-endotheliomatous tumors. According to Bell, hypoblastic overgrowth is the commonest and epiblastic least common. In the other group, are the homogeneous monocellular type of tumors which, according to one view (Chevassu and Bell), arise from the adult cells of seminiferous tubules just as cancer develops from an uncontrolled proliferation of adult cells from other glandular structures but, according to Ewing, are a one-sided cancerous overgrowth in a tumor primarily tridermal. Whatever view is adopted, the clinical distinction of a mixed tumor or teratoma from a homogeneous monocellular tumor or seminoma is of considerable importance. It seems fairly well established that the seminoma is radiosensitive but that the teratoma is radioresistant. Both are highly malignant and metastasize by preference through primary lymphatics. Sarcoma is now known to be a very rare tumor of the testis, although in the past it was frequently reported and probably referred to the pure round-celled seminoma. The only pure sarcomata of the testis are those arising from a connective tissue framework of which lymphosarcomata are commonest. Fibrosarcoma may arise from testicular tunics. Other sarcoma-like areas of heterogeneous tumors are in all probability a mesoblastic overgrowth of the testicular tumor or a type of sarcomatous change to which Bell applies the term "carcino-sarcoma" occurring in a structure essentially carcinomatous. For practical purposes, therefore, the clinician can recognize a mixed tumor or teratoma, in which the rare chorio-epithelioma belongs, and the pure unicellular seminoma with which the questionable sarcoma can be satisfactorily grouped.

A marked pathological characteristic of both these two types of tumors is mode of metastasis. Teratoma tends to metastasize earlier by way of primary lymphatics than seminoma but either type may show early general metastases, particularly to the lungs and liver. The primary lymphatic chain of the testicle has been well established anatomically and is the so-called pre-aortic lymph zone (Fig. 1).

Clinical characteristics. The cases of testicular tumors can be divided into three definite clinical groups, according to the nature of the growth and the absence or presence of evidence of metastases as determined by abdominal palpation of glandular masses or the X-ray indication of lung or other invasion. Group 1, the seminoma with or without clinical evidence of metastasis; group 2, the teratoma with clinical evidence of metastasis; and group 3, teratoma without clinical evidence of metastasis. This grouping is of importance in the application of surgery.

Therapeutic characteristics. There are now three recognized procedures in the treatment of testicular tumor: (1) simple castration, (2) palliation with or without castration, and (3) radical operation in which the testicle and its primary lymph zone are removed. The fact that the seminoma type tumors are radiosensitive and the teratomata are not gives at once a basis for differentiation of tumors with reference to surgical treatment. Experience has also taught that if metastases are evident on clinical study, neither

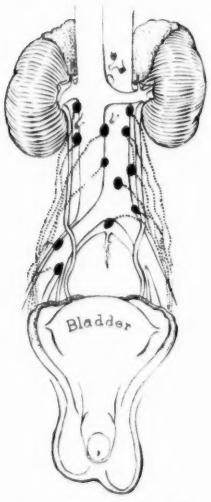


Fig. 1. The primary lymphatic chain of the testicle.

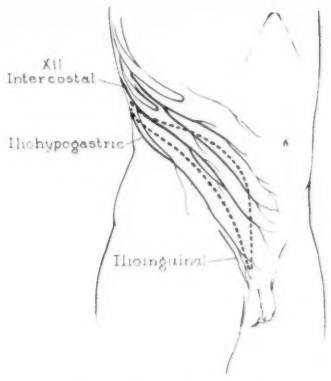


Fig. 2. Line of incision.

simple castration nor an attempted radical operation can be successful. This means that the clinical group 1 above should be treated by radiation either with or without castration, that group 2 is a hopeless group and can only be treated palliatively which, until more is known about the effects of radiation, does not prohibit its trial in all these advanced cases, and that group 3 are the only cases in which an attempt to perform a radical operation is ever indicated. It will be found that there will be a certain number of cases in which radical operation is attempted and in which there had been no clinical evidence of metastases but in which inoperable masses will be found. It is at once obvious that simple castration will cure only those cases in which the testicle has been removed before any metastases have occurred, that there will be a certain number of radical operations before metastases have occurred but that in those cases in which metastases have spread into the primary pre-aortic lymph zone, their radical removal is the only hope of cure when radioresistant.

The radical operation for teratoma testis. The feasibility and ease of an anatomical dissection of the primary pre-aortic lymph zone of the testicle is now fully established. More than 100 cases of radical resection have been performed by American surgeons with only one surgical death from pneumonia 10 days after operation. This is sufficient proof that the operation itself is neither dangerous nor difficult. With these 100 are included 20 cases which were found after retroperitoneal exposure to be inoperable, which means that a large number of other cases must have presented difficulties of gland resection from vena cava and aorta but in all of which no serious damage or surgical injury was done as there has been no case of hemorrhage or accidental death at the time of operation. The technical steps of the operation have been thoroughly described elsewhere[1] and are indicated in Figures 2, 3 and 4. The objection by those who have not done the operation that the whole gland area cannot be removed anyway and so why attempt it is answered by proof of cure by lymphatic resection of cases with lymph gland metastases. The completeness and thoroughness of the gland resection depends as much on courage, determination and a conviction that the procedure is right as on skill. The experience of Hepler cited below indicates that the abdominal resection should be extended above the renal pedicle.

In order to evaluate the results obtained by this operation, the cases of clinical group 3, teratoma without clinical evidence of metastasis, may be advantageously subdivided into subgroup A, cases which proved to be inoperable or with mistaken diagnosis and which, therefore, can be omitted from the consideration, subgroup B, cases in which the lymphatics removed at operation show no evidence microscopically of metastasis, and subgroup C, cases in which microscopic evidence of metastasis is found in the lymphatics successfully removed. From what has been said, it is

[1] Hinman, Frank. The radical operation for teratoma testis with the report of five cases. Surg., Gynec. & Obst., 1919, xxviii 495–508.
Hinman, Gibson, and Kutzmann. The radical operation for teratoma testis; An analysis of seventy-nine cases, ten of which are personal. Ibid., 1923, xxxvii, 429–451.

Fig. 3. *A*, Exposure of cord; *B*, division of cord with cautery; *C*, stripping back peritoneum.

obvious that all cases of teratoma in subgroup C could be cured only by radical surgery. It is still an open question whether in a case of pure seminoma, with or without clinical evidence of metastases (clinical group, 1) radical resection should be attempted or entire trust put in deep X-ray therapy.

The cases which are analyzed have been gathered from four sources: (1) personal cases of radical operation; (2) cases of radical operation by other American surgeons, the majority of which have never been reported and the information regarding which has been obtained by letter; (3) cases of simple orchidectomy with or with ut radiation, gathered from the same source; nd (4) authentic cases of 5 year cures of abdom al metastases by deep X-ray reported to the (li-fornia Cancer Commission.

Twelve personal cases. There are 9 pers al cases which were successful (3 in Group A x-cluded), all but one of which (Case 4) had te o-ma.[1] In 3 cases (Cases 6, 8, and 9) no microsc ic evidence of metastases was found in the g nd tissues removed. One died within 11 months th

[1] Two radical operations have been done since this paper was w en, in one (Von Holt), no metastases were found in tissues removed, the other (Thomas) numerous metastatic glands were removed.

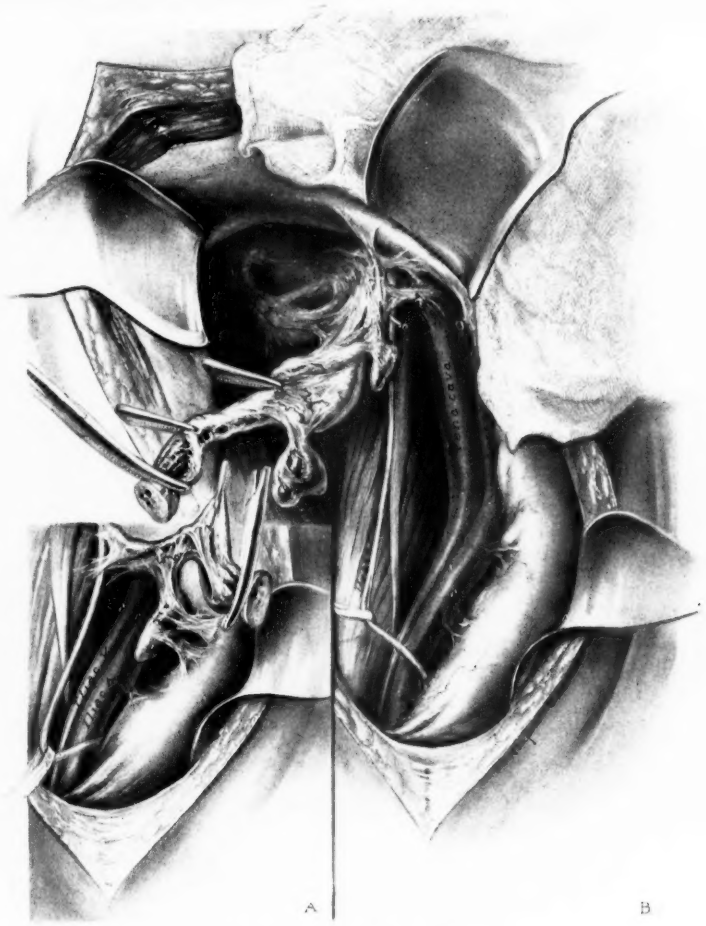


Fig. 4. Completion of operation.

extensive metastases to lung, liver, and abdominal glands. The other 2 are alive, Case 8 for 8 years and 9 months, Case 9 for 2 years and 10 months. In 6 cases, microscopic evidence of metastases in the gland tissues removed at operation was found. Three have died of carcinomatosis, Case 1 within 9 months, Case 4, 18 months, and Case 6, 11 months. Of the 3 cases living, all were alive and well at last report, Case 2, 14 years and 8 months, Case 3, 2 months (when last heard from, September 20, 1918), and Case 8, 4 years and 10 months. This gives a cure in 2 cases in which metastases were removed surgically (namely Cases 2 and 5) and in one case in which no metastases were found or removed surgically (Case 8). The facts relative to these 9 cases, and the patients' names, are given in Table I.

Ninety-one cases of radical operation by other American surgeons. The information of this series of 91 cases was obtained by letter sent to all members of the American Urological Association and to a few general surgeons who it was known had done the operation or of whom this was learned from the answers of some of the urologists. These cases are analyzed in four subgroups: (1) Twenty cases in which the operation was attempted but found impossible of completion; subgroup A, inoperable cases, Table II. (2) Thirty-three cases in which no microscopic evidence of metastasis was found in the lymphatic

TABLE I.—NINE PERSONAL CASES—3 GROUP A NOT INCLUDED

Three cured, thirty-three and one-third per cent

Reported 1919	Reported 1923	Present report 1932	Type of tumor	Date of radical operation	Lymphatic metastases	Surgical subgroup	Result	
							Dead	Living and well last report
5 (Dr. Eloesser)	1 (Dr. Eloesser)							
1 Larson	2 Larson	1 Larson	T	12–13–17	+	(C)	9 mos. Lungs Glands	
2 Wilds	3 Wilds	2 Wilds	T	1– 9–18	+	(C)		8–22–32 14 yrs., 8 mos.
3 Camp	4 Camp	3 Camp	T	7–27–18	+	(C)		9–20–18 Lost 2 mos.
4 Purnell	5 Purnell	4 Purnell	S	7–24–18	++	(C)	18 mos. Right kidney Glands	
6 Winter—A	6 Fisk—TB							
	7 Loveland —TB							
	8 Monseign-eur	5 Monseign-eur	T	1– 4–21	++	(C)		10–19–25 4 yrs., 10 mos.
	9 Katch	6 Katch	T	6–30–22	None	(B)	11 mos. Liver Lungs Glands	
	10 (Dr. Hepler)							
		7 Shatz	T	1– 8–25	1 gland at renal pedicle + Highest one removed	(C)	6 wks. Cervical glands Liver Glands	
		8 Buckalew	T	1–21–24	None	(B)		9–15–32 8 yrs., 9 mos.
		9 Pond	T	12– 3–29	None	(B)		10–27–32 2 yrs., 10 mos.

T—teratoma; S—seminoma.
Cured 3; 33⅓ per cent.

tissues successfully removed; subgroup B, Table III. (3) Thirty-five cases in which evidence of cancer was found microscopically in the lymph glands removed at operation, subgroup C, Table IV. And (4) three cases of radical resection in which the operator failed to state the type of tumor and whether or not metastases were present, included in Table IV.

Results of radical resection. If the inoperable cases are excluded and the 9 personal cases, included, there remain 80 successful radical resections, and the results are summarized in Table V. Because the monocellular type tumors (seminoma) are supposedly radiosensitive and the mixed type tumors (teratoma) are radioresistant, a careful distinction should be made until this point is proved or disproved.

In 36 of these 80 cases no metastases were found. Presumably simple castration would have cured them. As a matter of fact, metastases may have been present and missed by the pathologist. The case of Hepler of Seattle is particularly important: death 7 years *with metastases above the renal pedicle* after radical resection of the whole gland area below this level in which no evidence of metastasis was found; and Hepler states that the same pathologist has noted this high situation of metastases in one or two other autopsies after death from testicular tumor. The death from carcinomatosis 7 years after operation shows that even 5 years is not absolute security against recurrence with such highly malignant growths. Nevertheless, 11 of these 36 cases are living 5 years or longer. Twenty others are alive for shorter periods (2, between 4 and 5 years) and only 5 are known to be dead. Many of these cases had radiation but there were only 4 known seminomata (radiosensitive tumors) and 2 of these were dead, so that radiation could not have been particularly responsible. Of the 17 known teratoma 6 were cured. It is more likely that castration before metastasis or that resection of very early and

TABLE II.—SURGICAL SUBGROUP A

Case No.	Surgeon	Date of radical operation	Type of tumor	Lymphatic metastases	Dead and cause
[illegible]	Belt	—	T	++	9 mos. Lung metastasis
[illegible]	Mathé	—	S	++	Dead
[illegible]	Mathé	—	S	++	Dead
[illegible]	Cahill	—	—	++	*
[illegible]	Cahill	—	—	++	†
[illegible]	MacGowan	—	—	++	Short time after operation
[illegible]	Young (10,449)	—	—	++	3 mos. Metastasis to abdomen, lung
8	Olsen	—	T	++	4 mos.
9	Sullivan	—	T	++	1 mo.
10	Terry	—	T	++	‡
11	Meads	—	—	++	Several wks. after operation
12	Meads	—	—	++	Several wks. after operation
13	Ravenel (Negro)	—	S	++	3 mos.
14 to 18	Mark (5 cases)	(X-ray and radium)	—	++	All dead within 1 yr.
19 and 20	Kreutzmann (2 cases)	—	—	++	Both dead. Lung metastasis.

T—teratoma; S—seminoma.
*Result, living and well last report, 3½ yrs.
†Result, living and well last report, not stated.
‡Result, lost.

initial metastasis is the real factor back of the 11 cures. Thirteen, or 50 per cent, are alive and well 4 years and longer.

In 41 of these 80 cases, metastases to pre-aortic lymph nodes were found, in 7 seminomata and 24 teratomata (type not stated in 10). There is the one surgical death of the whole series in this group, 10 days after operation, of pneumonia. Twenty-three of the 41 cases have since died of metastases, the majority within 1 year, 17 are living, 6 of these 5 years or more (2, seminomata; 1, not stated; 3, teratomata). If teratomata are really and always radioresistant, then these 3 cures are directly attributable to successful radical resection of the pre-aortic lymphatics.

The series of 100 cases are summarized in Table V. Of the 80 cases "successfully" operated upon, 35 per cent are dead of metastases and 63.75 per cent are living, of which 17 cases or 20.1 per cent are cured (alive and well 5 years or longer).

The results of orchidectomy with or without radiation. In answering the questions about radical

TABLE III.—SURGICAL SUBGROUP B

Case No.	Surgeon	Date of radical operation	Type of tumor	Lymphatic metastases	Result: Living and well last report
1	Eloesser	11–20–24	S	None	1922, 8 yrs.
2	Hepler	1925 (Deep X-ray for 1 yr.)	S	None	‡
3	Olsen	2–16–28	T	None	10–10–32, 4 yrs., 8 mos.
4	Gibson	—	T	None	Oct., '31, 27 mos.
5	Kutzmann	2–21–28	T	None	10–21–31, 3 yrs., 9 mos.
6	Hyman	—	S	None	§
7	Patch	1924	T (carcinoma)	None	Nov., '31, 7 yrs.
8	Patch	1927	Embryoma with tuberculosis	None	Nov., '31, 4 yrs.
9	Wear	—	T	None	8 yrs.
10	Wear	—	T	None	6 yrs.
11	Sargent	—	S	None	11–5–31, 2 yrs.
12	Kramolowsky	1930	T	None	10–30–31, 1 yr.
13	Barringer	—	T	None	**
14*	Barringer	—	T	None	**
15	Barringer	—	T	None	**
16	Barringer	—	T	None	**
17	Belt	—	T	None	††
18	Wangensteen †	2–17–26	T	None	8–20–32, 6½ yrs.
19	Cahill	—	—	None	4 cases alive and well up to 6 yrs., subgrouping not stated. 1 Case not seen or heard from in 2 yrs.
20	Cahill	—	—	None	
21	Cahill	—	—	None	
22	Cahill	—	—	None	
23	Young (4106)	—	—	None	‡‡
24	Young (7666)	—	—	None	1½ yrs.
25	Keyes	—	—	None	Not followed
26	Keyes	—	—	None	Not followed
27 to 33	Lowsley	—	—	None	7 cases Not stated

T—teratoma; S—seminoma.
*Before introduction of radium.
†"None of the three patients following operation or at any time were unusually ill. I have heard this operation described as 'frank butchery.' My experience with it would indicate that it is purely an anatomical operation and that it can be done with no great difficulty."
‡Death: 1932; Cause: Glands above (7 yr.) renal pedicle.
§Death: 1 yr.; Cause: Intra-abdominal metastasis.
††Death: 16 mos.; Cause: Metastasis.
‡‡Death: 1 yr.; Cause: Abdominal metastasis.
**Lost.

TABLE IV.—SURGICAL SUBGROUP C

Case No.	Surgeon	Date of radical operation	Type of tumor	Lymphatic metastases	Result	
					Dead and cause	Living and well last report
1	Hepler	June, 1922	S	+		1927—over 5 yrs.
2	Gibson	8-14-25	T	+ +	6½ mos.	
3	Foley	7-1-30	S	+ +		12-8-31, 1 yr., 5 mos.
4	Ferguson	Feb., 1928	S	+	3 yrs. Metastasis	
5	Ferguson	Dec., 1929	S	+		Sept., 1931, 1¾ yrs.
6	Patch	1926	T	+	18 mos. Metastasis	
7	Wear	—	T	+		5 yrs.
8	Hess	—	T	+	1 yr. Metastasis	
9*	Hess	—	T	+	1 yr. Metastasis	
10	Wright	—	T	+ +	6 mos. Lung metastasis	
11	Sargent	—	S	+		11-5-31, still convalescing
12	Powell	—	T	+	4 yrs.	
13	Powell	—	T	+	1 yr.	
14	Whitty	—	T	+	10 days. Pneumonia	
15	Whitty	—	T	+	5 mos.	
16	O'Conor	—	T	+	7 mos. Metastasis	
17	O'Conor	—	T	+	14 mos. Metastasis	
18	O'Conor	—	T	+	19 mos. Metastasis	
19	Colby	7-6-31	Embryonal carc.	+		Nov., 1931, has metastasis in lung
20	Colby	—	Embryonal carc.	+	2 mos. Unassociated with metastasis	
21	Belt	—	T	+	Dead. Lung metastasis	
22	Belt	—	T	+	Dead. Spinal cord metastasis	
23	Querner	10-14-31	Embryonal carc.	+	1-8-32. Cervical gland metastasis size of hen's egg	
24	Wangensteen	6-9-29	–	§	Oct., 1930. Liver and gland metastasis	
25	Wangensteen	8-8-32	Not stated	+ + +		Convalescing
26	Cahill	—	Not stated	+	1 yr. Lung metastasis	
27	Cahill	—	Not stated	+	1 yr. Lung metastasis	
28	Young (9142)	—	Not stated	+		9 yrs.
29	Young (9151)	—	Not stated	+ +	2 yrs. Abdomen and lung metastasis	
30	Young (10,862)	—	T	+	5 mos. Lung and liver metastasis	
31	Young (11,522)	—	Not stated	+		1 yr.
32 to 34	Lowsley 3 cases	—	Not stated	+		Not stated
35	MacGowan	‡	"Sarcoma" (S)	+		20 yrs.
36	Ferguson	—	S	Not stated		6-22-31
37	Barney	—	? (Lab. report lost)	?		Made good recovery from operation, lost from observation
38	Young (11,062)	—	Not stated	Not stated		1 yr.

See footnote on opposite page.

TABLE V.—SUMMARY BY SURGICAL GROUPS OF ONE HUNDRED CASES OF RADICAL SURGERY BY AMERICAN SURGEONS (INCLUDING TWELVE PERSONAL)

			Operative deaths	Died of metastases	Living		
					Not stated	Under 5	Over 5
Group A—Found to be inoperable	Seminoma	3	None	3	—	—	—
	Teratoma	4	None	3	1	—	—
	Not stated	13	None	11	1	1	—
		20		17	2	1	—
Group B—No metastases found in tissue removed	Seminoma	4	None	2	—	1	1
	Teratoma	17	None	2	4	5	6
	Not stated	15	None	1	9	1	4
		36		5	13	7	11
Group C—Metastases found and removed presumably completely	Seminoma	7	None	2	—	3	2
	Teratoma	24	1–10 days of pneumonia	17	1	2	3
	Not stated	10	None	4	3	2	1
		41	1	23	4	7	6
Type of tumor and metastatic findings neither one stated		3	None	0	1	2	—
Total		80	1	28	18	16	17
Per cent				35	42.5	63.75	20.1

Total operations, Groups A, B, C, 100.
Operative deaths, 1.

surgery submitted by letter to American urologists, the following facts relative to results following simple castration with or without pre-operative and postoperative radiation were obtained. About 258 cases are listed in Table VI which gives the source of the information and the results, which are summarized in Table VII. Of the approximate 258 cases, 118 are dead, 124 are living but only 17 for 5 years or longer, *a cure of only about 6 per cent.*

Five year cures of abdominal metastases by deep X-ray. The Cancer Commission of the California State Medical Society has been actively at work for some time. Recently, two subcommitteemen sent out to all members of the Radiological Society and of the western branch of the American Urological Association the following question:

Have you seen 5 year cures following radiation treatment of abdominal lymph gland metastases in testicular tumors? Six radiologists replied in the affirmative, listing more than 12 cases, and 10 urologists said "yes," listing 23 cases; giving the very encouraging total of 35 cures by radiation of cases hopeless from a surgical standpoint. The radiological committee chairman and the urological committee chairman have very kindly given me the names of the doctors reporting these cases and, in order that the record be one of fact and not one of "shrewd inference," each one has been written for details regarding the cases observed by him. The result, summarized in Table VIII, is very disappointing, showing a probably authentic cure in only 3 cases, *but these 3 cases prove that certain types of testicular tumor are very radiosensitive and that deep X-ray therapy can cure some cases which are absolutely hopeless otherwise.*

SUMMARY

It is illogical to compare on their face value the different series of cases mentioned. That is not the present purpose. Rather is it a desire to determine whether radical operation is ever a justifiable procedure. The results of the 80 radical operations have the advantage in comparison over those of simple orchidectomy of being a selected group—cases in which no clinical evidence of metastases could be found—and a fair comparison would be with a similar selected series treated by simple orchidectomy. The results as presented, however, are summarized for comparison in Table IX, showing 17 cures in 80 cases of radical surgery with one operative death as against 17 cures in 258 cases of orchidectomy without an operative death. Indisputable evidence

T—teratoma; S—seminoma.
* Of 9 cases, 2 had radical operation and all the other 7 died within 2 years.
§ Subgrouping not stated.
† "My impression is that all the lymph nodes were probably involved, but repeated examination failed to reveal any involvement because of previous X-ray treatment."
‡ Testicle removed together with skin of scrotum, adjoining skin of thigh and lower abdomen and accompanying lymphatics, cord and spermatic vessels up to the hilum of the kidney and down to the ampulla of the vas.
§ Given X-ray previous to operation and pathologist unable to find evidence of malignancy in testis or glands after radical removal

TABLE VI.—ORCHIDECTOMY CASES

No.	Name	Date	Radiation		Type of tumor	Clinical metastases	Result		
			Pre	Post			Death Date and cause	Lost	Well
1 to 4	Coppridge	Not given		3	T	2: none 2: not mentioned	6 mos. Not given	1	1: 7 yrs. 1: 5 yrs.
5 to 9	Cumming	Not stated			T	3: yes 2: no	3 dead. Not given		1: "cure," time not stated 1: 3 yrs.
10	Butler	2-6-28		Yes	T	Not stated			1: 3½ yrs.
11 to 13	Cecil	Not stated		Yes	T	Not stated	1: 6 mos. Not given		1: 1 yr. 1: 6 mos.
14 and 15	Herrick	Not stated			S, "embryonal carcinoma"	1: no 1: not stated	1: 9 mos., metastasis		1: 3 yrs.
16 to 20	Muellerschoen	Not stated		Yes	T	Not stated			5: 1½ yrs.
21 and 22	Wollheim	1-26-26 4-13-29	Yes	Yes	"Bilateral lymphosarcoma" "Embryonal carcinoma" T?	No No	1: 6 mos. General abdominal masses		1: 7 mos.
23 to 25	Cerf	Not stated			S	Not stated		1	2: "no difficulty," date not given
26 and 27	Parkins	Not stated		Yes	1: "Sarcoma" 1: T	No No			2: 6 mos.
28 and 29	Patterson	Not stated	Yes		T	Not stated		2	
30 to 33	Parmenter	April, 1931 8-3-29 6-27-30 6-24-31			S S S S	Not stated Not stated Not stated Not stated			1: 9 plus years 1: 1½ years 1: 1 plus year 1: 1 month
34 to 37	Foulds	Not stated			T "Embryonal carcinoma"	Not stated			1: 5 years 1: 3 years 1: 6 months 1: 1 month
38 to 46	Fowler	1: 1-13-30 8: Not stated		1: yes 8: not stated	1: S 8: not stated	Not stated	3 dead. Metastasis		1: 1½ years 1: 12 years 1: 6 months 1: has late metastasis time not stated
47 and 48	Wade	Not stated	Yes	Yes	T	Not stated	2 dead. Metastasis (1: 11 mos., 1: ?)		
49 50	Ormond	Not stated			S	Not stated			1: 3 years 1: 5 years
51 to 55	Wood	Not stated		Yes	2: T 3: S	Not stated	1: (T) d. 6 mos.		1: (T) 2 mos. 3: (S) Living 1930 and 1931
56	Bryan	Not stated			T				"Good result"
57 to 59	Scholl	11-24-29 5-13-30 2-4-30	Yes Yes Yes	Yes Yes Yes	T T S				1: 2 years 1: 1½ years 1: 1 yr., 8 mos.
60 to 63	Kersten	Not stated			T (4)		2 dead. Metastasis		2: Living and well

T—teratoma; S—seminoma.

TABLE VI.—ORCHIDECTOMY CASES—Continued

No.	Name	Date	Radiation		Type of Tumor	Clinical metastases	Result		
			Pre	Post			Death Date and cause	Lost	Well
64 and 65	Morton	Not stated		Yes	Not stated		1: 3+ yrs. Abdominal metastasis		1: 10 months
66	McCune	Not stated			T		1: 2 yrs. Brain metastasis		
67	Stilson	Not stated			T				1: 1¼ yrs.
68	Van Denburg	7-1-28			S				1: 3½ yrs.
69	McKay	Not stated		Yes	T				1: 8 yrs.
70	B. W. Turner (3 other cases not included because not operated upon)	Not stated			Mixed				1: 3 yrs.
71 to 73	Balch	Not stated			1: T 2: Sarcoma		2 dead. Recurrence		1: 20 yrs?
74 to 78	Backus	Not stated			5: T		5 dead. 2: 1 mo., cause? 3: 2½ yrs. Metastasis		
79 to 85	Hennessey (2 other cases not included because of lack of information)	Not stated		Yes (6) 1: Not stated	6: Embryonal carcinoma 1: Carcinoma Sarcoma		2 dead. (4 and 5 mos., metastasis)		1: 2 yrs. 1: 2½ yrs. 1: 3½ yrs. 1: 5 yrs. 1: carcinoma just discharged from hospital
86	McNulty	Not stated			S		1 dead, refused radical removal of lymph nodes and left hospital		
87	Ferguson	June, 1931			S				1: 5 mos.
88 to 90	Vander Veer	1: 9-10-28 2: Not stated	2: Yes 1: Not stated	2: Yes 1: Not stated	3: T		1: 6 mos. General metastasis		1: 1 yr. 1: 5 yrs.
91 and 92	Olsen	1: 4-3-31 1:		1: Yes	1: Carcinoma 1: T	1: Yes	1: 8-1-31. (4 mos.). General metastasis 1: 3 mos. Local infection prevented radical operation. Patient returned later but died of metastasis before radical operation was performed		
93 to 98	O'Conor	Not stated			6: T				1: 8 yrs. 2: 7 yrs. 1: 4 yrs. 2: Not stated
99 to 105	McKiernan	Not stated			7: T			5: Lost	1: 4 yrs. 1: 2 yrs.
106 to 150	Lower (45 traced cases)	14: dates? 27: dates?	7: Yes 15: Yes 2 radium only	7: Yes 15: Yes	16: T 29: S		22 dead	2: Lost after 1 yr. (T)	Of 16 T: 9, 1-2 yrs. 2, 3-4 yrs. 2, 5-9 yrs. 1, Not stated Of 29 S: 17, 1-2 yrs. 9, 3-4 yrs. 2, 5-9 yrs. 1, 10 yrs.
151 to 159	Burt	9: Date?	Yes	Yes	Not stated		6: Cause not stated		1: 1 yr. 1: 2 yrs. 1: 3 yrs.
160 to 167	Gregg	+					6: Cause not stated		2: 3 yrs.

—Teratoma; S—seminoma.

TABLE VI.—ORCHIDECTOMY CASES—Continued

No.	Name	Date	Radiation		Type of Tumor	Clinical metastases	Result		
			Pre	Post			Death Date and cause	Lost	Well
168 to 178	Deming	+			2: T 9: S		9: Within 18 mos.		1: 3 yrs. 1: 4 yrs.
179 and 180	Strohm	+					1: 6 mos.		1: 9 mos.
181 to 183	Fleischman	+			2: T 1: S		3: (1, 1 yr., 1, 1½ yr., 1, 6 mos.)		
184 to 186	Dillingham	+					3: (6 to 8 mos.)		
?	Ritter	+					All dead: metastases to lung and retroperitoneal glands		
?	Davison	+	Yes	Yes			All dead		
3+	Schoonover	+			2: T 1: S		All dead		
5+	Peacock	+					All dead		
2+	Garlick	+	X-ray		2: T				1: 3 yrs. 1: 4 yrs.
?	Greene	+					All within 2 yrs.		
1+	Ehrich	+					Metastasis		
?	Hunter	+			Major-ity: T		Those followed all dead		
2+	Burns	+		1: X-ray			1: 2 mos. Pulmonary metastasis (X-ray)	1	
3+	Fischel	+					All dead		
1+	Ravenel	+			S		1: several mos.		
2	Allen	−		2: Deep X-ray					1: 1 yr. 1: 2½ yrs.
?	Johnston	+		X-ray			All dead		
6?	Crockett	+					All dead		
4+	Carroll	+			3: T 1: S		1: 2 yrs. 1: 3 wks.	2	
7+	Bratrud	+					All within 2 yrs.		

T—teratoma; S—seminoma.

TABLE VII.—ORCHIDECTOMY WITH OR WITHOUT RADIUM AND X-RAY

	Seminoma	Teratoma	Not stated	Total
Cases	79	97	82	258
Pre-operative radiation	—	20	—	—
Post-operative radiation	14	55	12	—
Patients dead	20	31	67	118
Patients lost	1	12	3	16
Result—not stated	7	7	—	14
Living—1 year	27	25	7	59
Living—2 years	3	1	2	6
Living—3 years	14	9	3	26
Living—4 years	1	1	—	2
Living more than 5 yrs.	6	11	—	17

Total living 124 or 48.4 per cent.
Cured 6.0 per cent.

of the value of radical surgery is given by the cure of 3 cases of radioresistant teratomata in which

TABLE IX.—SUMMARY

	Cases	Dead	Not stated or lost	Living	
				Under 5 years	Over 5 years
I. Radical operation	80	29	18	16	17
II. Orchidectomy with or without radiation	258	118	30	93	17
III. Five year cures of abdominal lymph gland metastases	35	—	—	—	

TABLE VIII.—FIVE YEAR CURES OF ABDOMINAL LYMPH GLAND METASTASES IN TESTICULAR TUMORS BY DEEP X-RAY

Summary of replies to the California State Cancer Commission questionnaire dated September 14, 1932

Affirmative radiologists, 6	Cases	Reply to request for details of these cases		
		Date	Summary	Confirmed
1. Zimmerman	A few	10- 6-32	"Have seen no 5 year cures nor even a 3 year cure."	
2. Ruggles and Bryan	5	9-30-32	"Only 1 case" "Julius Kohn," case of Dr. Henry Harris, bilateral tumors, first, deep X-ray, 1926, abdominal masses appeared in 1930, second deep therapy, now living and well	6 years
3. Levithin	1	10- 1-32	Case "Julius Kohn," same as above.	
4. Taylor	1 "living 3 years"		No reply	
5. Soiland, Costolow and Meland	2	9-14-32	"One case now being nearly 9 years and still well." No details	9 years
6. Dr. Kinney	2		No reply	
	12+			
Affirmative urologists, 10			(Dr. Mathé, chairman, letter dated September 10, 1932)	
1. Parker	12		No reply	
2. Reinle	1	10- 6-32	"Dr. Mathé must have misunderstood me, have not had a 5 year cure."	
3. Mathé	1		No reply	
4. Wesson	1		Reported in Am. J. Surg., 1927, Case 1, A. R., Orchidectomy, Feb., 1922, abdominal metastasis, 1924, 15 to 20 inguinal glands removed. X-ray by Dr. Rehfisch. "Apparently well," 1927. Type of tumor not stated	5 years
5. Jones	1	8-16-32	"Orchidectomy, 1925, Now dead, apparently of lung and abdominal metastases"	
6. Scholl	2	8-29-32	"Vaguely recollect seeing two cases at Mayo Clinic"	
7. Willard	2	Telephone 10- 4-32	"Seen a long time ago, records at St. Luke's Hospital"	
8. Davis	1	David M. Phoenix 9-14-32	"Mistake, not seen a case"	
		John B. Denver 9-27-32	"Do not recall such a case"	
9. Gibson	1	8-16-32	"Misinformed. Have seen no cases"	
10. Ingber	1	8-27-32	"No record of such a case and none seen by associates, Rodenbaugh and Kile"	
	23			

metastatic glands were removed surgically. It must be conceded that without radical surgery these patients must have died of metastases.

CONCLUSION

1. The radical operation for tumor of the testis is indicated in cases without clinical evidence of metastasis in which after orchidectomy the pathologist reports a mixed type tumor.

2. The surgical risk of the operation in the hands of American surgeons is about 1 per cent, a perfectly justifiable risk in view of the high morbidity following simple castration and X-ray.

3. The fact that at least 3 of 24 otherwise hopeless cases (24 teratomata with lymph metastases removed) have been cured by the radical operation proves its possibilities.

4. The fact that half of the cases (18 of 36) in which the pathologist could find no evidence of metastasis in the gland tissues removed are living (4 years or longer) indicates that radical surgery is preferable to simple castration even in these cases, and the surgeon should not feel that radical resection was unnecessary even though the pathologist tells him that he has removed no metastatic cancer.

FIVE YEAR CURES OF CANCER OF THE TESTIS, PROSTATE, AND BLADDER

EDWARD L. KEYES, M.D., F.A.C.S., NEW YORK

CANCER always begins as a local process and at its beginning is always curable. I am an example of the cure of cancer. Three cancers have been removed from my face by radium or actual cautery, the last in 1918.

Yet, contrast with these statements the fact that when I entered my father's office in 1897, I found only one recorded 5 year cure of cancer of the testicle (diagnosed by Dr. William H. Welch).

From that date onward cancer of the testicle in our records presents an unbroken series of what might well be termed violent deaths—lads in their 'teens and twenties apparently perfectly hale one day, dead within 2 years—until on October 18, 1916, there was brought to my office a man so pale, so gaunt, that he looked as though he might die on the doorstep. When he was stripped and stretched, one could see his belly wall bulged forward by a mass fully as large as the great tumor in his scrotum.

Radium pack was applied to the abdomen by Dr. H. H. Janeway at the Memorial Hospital. Two weeks later the patient was a changed man and had gained 5 pounds. The abdominal cancer could still be felt but no longer seen. (The testicle was then removed.) At the end of 4 weeks no mass could be felt in the abdomen. The patient was last heard from, perfectly well, in 1922. He had moved to another city and was too well to bother with doctors.

Since then the Memorial Hospital[1] records show a reversal of prognosis. The very cases that are quite incurable by surgery because of their malignancy are the most radio-sensitive. (These strikingly illustrate how cellular malignancy may fail to correspond with clinical malignancy.) The slow growing, nodular cancers of the testicle are cured by surgery if discovered early enough. The wildly malignant seminoma (such as the afore-mentioned case) requires both radiation and surgery. Yet, the patient is so slow to be alarmed by a painless enlargement of the testicle that actually the results of treatment seem better today for the more malignant seminoma than for the radioresistant slow growing tumors (about 25 per cent of 5 year cures).

Cancer of the prostate presents quite the opposite picture. I have not a single 5 year cure to report for the reason that no method of early diagnosis and therapy really fulfilled my requirements until within the past 5 years. But our present conception of prostatic carcinoma, and the present prospects of the patient who can be cured, as well as of him who cannot, are wholly different from what they were 10 years ago. One may safely prophesy that many 5 year cures will be on record by 1950. Indeed, a number are recorded already.

Cancer of the bladder presents a prognostic picture quite different from that of prostatic cancer.[2] It gives symptoms relatively early, it is easily diagnosed, it usually attacks the base of the bladder whence dissemination is slow. Its cellular malignancy is often slight. Yet a generation ago Guyon, the founder of modern urology, said, "Nous attendons dans la clinique les papillomes de la statistique." For the tumors of low cellular malignancy recurred and slew in spite of good surgery, until the high frequency current and radium came into use.

My first 5 year cure of proved bladder cancer dates from 1919.

Mrs. M., 71 years of age, consulted me in October, 1914, after she had been advised by an eminent urologist that she had cancer of the bladder which would require resection. I found a large papillary tumor, presumably of relatively slight malignancy, to the left of the trigone. No induration was felt from vagina or rectum. Cystoscopic fulguration was given six times without benefit. A specimen submitted to Dr. James Ewing was reported carcinoma. Dr. Barringer then put a silver capsule containing 200 millicuries of radium emanation into the bladder for 7 hours. The bladder irritability that followed this lasted for 3 months, and even after 6 months a radium ulcer was seen in the bladder. But after a year cystoscopy showed no tumor. The bladder remained clean until January, 1919. The radium treatment was then repeated and again she had several months of bladder irritation and in the summer of 1919 I destroyed a papillary tumor of the bladder vault by cystoscopic fulguration. Annual cystoscopies until 1921 showed no return of tumor. Patient was last seen in January 1932, 89 years old, perfectly well, 13 years after the last treatment.

The low malignancy of this tumor is illustrated by the absence of metastases during 5 years of treatment.

In my second case, a patient with a more malignant growth, operation was done in 1921. The history of this case follows.

[1]To which I send all my teratoma cases.

[2]The cases mentioned in this report will be made the subject of a more detailed report.

Mrs. W., operated upon 3 years after the beginning of her symptoms on March 7, 1921, at the age of 70 years. Her tumor was described by the physician who referred her as follows: "There is a large growth on the left lateral wall which shows two or three bleeding points, and a large area of ulcerated surface which is covered with a shaggy layer of fibrinous exudate. This tumor is hard and nodular and involves left ureter. It is undoubtedly malignant and absolutely inoperable with any hope of future comfort to patient." At operation I found a tumor "covering the left angle of the trigone and adjoining base, about 4 by 2 centimeters in size and raised about 5 millimeters." Glass tubes of radium emanation amounting to 633 millicurie hours were implanted and two capsules of silver screened emanation left in the bladder, the radiation from which was estimated at 490 additional millicurie hours. No attention was paid to a small secondary papillary tumor in the urethra. A small specimen was taken and found to be carcinoma, many years later graded as II. Postoperative radium irritation lasted about 3 weeks and it was 8 weeks before the suprapubic wound was healed. Cystoscopy at various periods up to 3 years after operation showed no return of the tumor. When last heard from in 1931, at the age of 82 years, 10 years after operation, patient was quite senile but had normal bladder function and no recurrence.

Since 1925, with the exception of an occasional resection, my bladder cancers have been treated by implantation of so called seeds of gold or platinum varying from 1 to 2.5 millicuries of radium emanation. In my records previous to 5 years ago I find 69 cases of bladder cancers proved microscopically. Forty-seven were treated by radium emanation implantation and 17 (36 per cent) of these have survived 5 to 10 years (alive and well excepting one who died following a negative exploration of his abdomen by another surgeon). The remaining 22, treated by other—presumably curative—procedures show a 10 per cent 5 year survival.

SUMMARY

The cases cited illustrate the fact that cancer in this generation, like tuberculosis in the preceding one, is becoming each year more and more a curable disease.

MALIGNANCY OF CEREBRAL TUMORS

WINCHELL McK. CRAIG, M.D., F.A.C.S., ROCHESTER, MINNESOTA
Section on Neurologic Surgery, The Mayo Clinic

TUMORS of the central nervous system have been diagnosed more accurately and treated more effectively as the result of the methodical pathological analysis instigated by a small group of investigators, who realized the necessity of classifying these tumors with regard to their relative malignancy.

This more careful analysis has amplified our knowledge of all tumors of the central nervous system, and particularly of tumors of the brain. These tumors produce definite symptoms which, however, may also be caused by other intracranial lesions, such as aneurisms, abscesses, subdural hæmatomata, traumatic cysts and inflammatory conditions such as arachnoiditis, involving either the cisterna cerebello-medullaris, the optic chiasm, or the cerebral hemispheres.

The entire group of brain tumors consists of pituitary adenomata, meningeal fibroblastomata, acoustic neuromata, congenital tumors such as craniopharyngeal pouch cysts and dermoids, metastatic tumors, granulomatous tumors of syphilitic or tuberculous origin, angioblastic tumors, and gliomata.

The gliomata arise from the substance of the brain; they comprise only 40 per cent of all intracranial tumors and were formerly considered incurable.

Within the last decade, these tumors have been analyzed pathologically and clinically by Bailey and Cushing, Penfield, Globus and Strauss, Roussy, Greenfield, Kernohan, and others, and due to their efforts, definite order has emerged from the chaotic condition which previously existed. Tumors of the glioma group are no longer considered as having all the same degree of malignancy or as giving all the same prognosis, and this of course influences the surgical attitude. The tumor can be classified at the time of operation, and if its removal is feasible, the operation can be planned in one or more stages, as indicated by the condition of the patient.

All tumors, regardless of their cellular nature, vary in malignant potentialities, and we are all familiar with the grading from 1 to 4 of malignant tumors which is based on cellular differentiation, and which proves of great assistance in deciding on a surgical program, as well as indicating the probable postoperative longevity.

Brain tumors of the glioma group are malignant in that they invade the surrounding structures and tend to recur, but do not metastasize to other parts of the body. They have been analyzed clinically and pathologically, in a manner similar to cancer elsewhere in the body. However, instead of attempting to grade their respective malignancy, based on the amount of cellular differentiation, they have been classified and tabulated according to the predominating cellular structure. The cells arising from the primitive medullary epithelium take on the characteristics of different types of cells, as development progresses toward adult and mature glial structures. These transitional cells have been designated spongioblasts, medulloblasts, astroblasts, and astrocytes. Tumors composed predominatingly of these cellular structures have been classified as spongioblastomata, medulloblastomata, astroblastomata, and astrocytomata. Other cells which may produce tumors are the oligodendrocytes and the ependymal cells.

Consequently, the nomenclature of gliomata thus evolved consists of such descriptive terms as spongioblastoma multiforme and polar spongioblastoma, medulloblastoma, ependymoma, and so forth. For the purpose of convenience, I am using only 7 of these divisions to illustrate the relative malignancy of these tumors and the distinct clinical and surgical advantage of their classification. These groups are being constantly changed, new names being added, and old names discarded, as analysis of the gliomatous tumors becomes more nearly universal and better understood.

The tumors which could be pathologically classified under spongioblastoma multiforme, medulloblastoma, astrocytoma, oligodendroglioma, astroblastoma, polar spongioblastoma, and ependymoma form the basis of this report, although there are other, smaller groups into which some of the gliomata can be divided.

Of these, the spongioblastoma multiforme and the medulloblastoma rank as the most malignant and would compare favorably with a carcinoma graded 4 elsewhere in the body. The average periods of survival of patients who have these tumors has been given as 12 and 17 months, respectively, making the possibility of a 5 year cure very remote. Fortunately, these two groups comprise only 41 per cent of the total group of gliomata. There is a distinct difference between these two

oups and the remaining divisions, because in l of the five remaining groups, it has been posble to trace 5 year cures. The astroblastoma, the endymoma, and the polar spongioblastoma can grouped together with regard to their malignt potentialities, and would correspond to tuors elsewhere in the body of malignancy, graded The astroblastomas represent 2 per cent of the gomata; the polar spongioblastomata, 7 per cent; d the ependymomata, 4 per cent, which gives a tal of 11 per cent for this intermediate group. he average period of survival of patients who ve such tumors is 28, 32, and 46 months, respectively.

The last combination of these pathological groups comprise the oligodendrogliomata and the astrocytomata, the cellular structure of which indicates malignancy of low grade; they would correspond in malignancy to carcinoma graded 1 elsewhere in the body. The astrocytomata comprise 27 per cent of the gliomata, and the oligodendrogliomata 18 per cent, in all 45 per cent; this is a greater proportion than that of tumors corresponding to grade 4. The average period of survival of patients who have astrocytoma has been given as 66 months and of those who have oligodendroglioma as 76 months.

Thus, it is apparent that investigation has completely changed the clinical and surgical attitudes toward intracranial gliomata, inasmuch as they have been found to comprise only 40 per cent of intracranial neoplasms, and of this 40 per cent, less than half fall into a group analagous to carcinoma graded 4 elsewhere in the body. About half the gliomata can be compared to tumors of malignancy graded 1 elsewhere in the body, and about 11 per cent can be compared with tumors graded 2.

Operability and prognosis concerning gliomata depend not only on their cellular characteristics, but also on their situation within the brain, on the invasion of surrounding tissue, and on the permanent injury which has resulted from pressure. In view of these facts, I have taken for analysis concerning 5 year cures only those patients who have remained relieved of symptoms over this period, and who have been able to return to work without any apparent aberration of function.

Five year cures followed total removal of tumors in all groups except those composed of spongioblastomata and medulloblastomata. In these two groups, relief was only palliative and temporary. Five year cures resulted in the group composed of astroblastomata, following total removal of tumors at the primary operation, subtotal removal followed by radiotherapy, and subtotal removal followed in 2 or more years by total removal at secondary operation. Five year cures resulted in the group composed of polar spongioblastomata following total removal of the tumor at the primary operation, total removal by means of three operative procedures at intervals of 2 years, subtotal removal followed by roentgen treatment, and removal of mural nodules in cystic tumors. Five year cures resulted in the group composed of ependymomata following total removal at the primary operation or in multiple stages, as well as subtotal removal with subsequent treatment by radium. Five year cures resulted in the group composed of oligodendrogliomata following total removal at the primary operation, and subtotal removal in two or three operations separated by intervals of from 1 to 3 years, and 1 patient was well for 5 years following decompression and one treatment with radium. Five year cures resulted in the group composed of astrocytomata, from total removal at the primary operation, from total removal following three operations, and from subtotal removal followed by treatment by means of roentgen rays and radium.

A review of the 5 year cures emphasizes the fact that more careful pathological analysis has been invaluable in classifying the tumors of the glioma group with regard to their operability and response to irradiation. In dealing with the most malignant group, comprising the types known as spongioblastoma multiforme and medulloblastoma, treatment can be only palliative, even when apparent total removal is followed by radiotherapy.

Tumors of the remaining groups, which are less malignant, have responded to one or more surgical procedures and irradiation, with resulting 5 year cures. It is rather difficult to estimate the value of treatment by radium and roentgen rays in treatment of these tumors at the present time, because in most of the cases in which 5 year cures occurred, radiotherapy was given at some time during the period of treatment. Repeated operations on the less malignant types of glioma have been followed by 5 year cures so consistently that it has become the treatment of choice, depending of course on the condition of the patient and the amount of permanent injury which has been produced.

It is apparent, therefore, that gliomata comprise only 40 per cent of intracranial tumors, and are not all hopelessly malignant. It is true that the more malignant tumors can be treated only palliatively, by operation and irradiation,

but the classification and analysis of this group of tumors have emphasized the fact that some of the more benign types respond to treatment so successfully that complete relief of symptoms follows one or more operations, and tumors of the entire group are not only receiving more efficacious treatment as time goes on but more permanent cures are being realized.

LARYNGEAL CANCER

STATISTICAL REPORT ON FIVE YEAR CURES

FIELDING O. LEWIS, M.D., F.A.C.S., PHILADELPHIA, PENNSYLVANIA

LARYNGEAL cancer may be intrinsic or extrinsic. The surgical treatment (laryngofissure) in early intrinsic cancer of the larynx yields a more striking and lasting result than can be claimed in any other internal region of the body; the lymphatic arrangement is to a marked degree confined; metastasis is, therefore, late. About 80 per cent cures is the reported results of experienced operators.

I have performed the operation of laryngofissure on 10 patients, with the following results:

The first patient, who died of recurrence, should have had a total laryngectomy. Four are free from any evidence of recurrence after more than 5 years: 1, 11 years 8 months; 1, 9 years 4 months; 1, 5 years 7 months; 1, 5 years and 2 months. The remaining 5 cases have not quite reached the 5 year period since operation, but are still free from recurrence.

Our records show that in the group of advanced intrinsic cancer in which total laryngectomy was performed, there are 83 cases; 52, or about 63 per cent, are living and remain free from the disease. Of the 52 living cases, 32 have passed the 5 year cure period, the longest period being 11 years since the operation.

In extrinsic cancer of the larynx with varying degrees of cervical lymphatic metastasis, extension to the tongue, pyriform sinuses and œsophagus, which only a few years ago were considered *hopeless*, are now promised a brighter future. In this group, we have operated upon 75 patients; 16, or slightly over 21 per cent, are living and enjoying life free from the disease beyond the 5 year period—the oldest in point of operation, being 12 years.

One patient with squamous cell carcinoma of the epiglottis is living and well after 7½ years following a subhyoid pharyngotomy. In all cases the diagnosis was confirmed by biopsy.

Fig. 1.

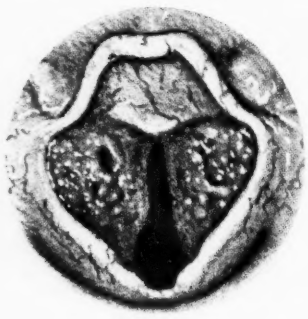


Fig. 2.

Fig. 3.

Fig. 1. Early epithelioma of the right vocal cord. Note the infiltrating type of lesion with inflammation of the cord. In this type of case 80 per cent of cures may be expected by laryngofissure.

Fig. 2. Advanced bilateral intrinsic cancer of the larynx. In this type of case, total laryngectomy offers a large percentage of cures provided there is not a marked glandular metastasis.

Fig. 3. Extrinsic cancer of the larynx. Total laryngectomy with dissection of the cervical glands, plus irradiation, have given most encouraging results in treating this type of laryngeal cancer.

Fig. 4. Extrinsic carcinoma of the larynx. Laryngectomy and excision of the upper portion of the œsophagus, November, 1921. Patient still living with no evidence of recurrence.

Fig. 5. Advanced intrinsic carcinoma of the larynx. Total laryngectomy February, 1922. Patient aged 34 years. No evidence of recurrence to date.

Fig. 4.

Fig. 5.

Fig. 6. Advanced intrinsic carcinoma of the larynx. Total laryngectomy, July, 1925. Still free from recurrence. Has a splendid buccal voice. At right, photograph of larynx removed from patient.

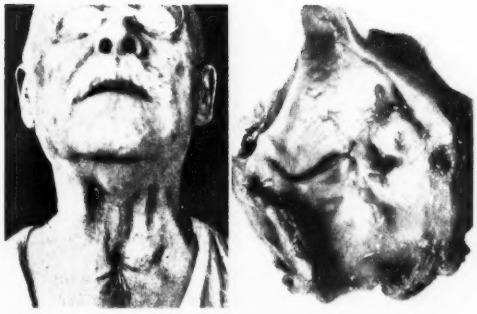


Fig. 7. Physician, aged 76 years. Advanced intrinsic carcinoma of the larynx. Total laryngectomy February, 1926. Still free from recurrence. Continues in the practice of medicine. At right, photograph of larynx removed.

MALIGNANT TUMORS OF THE EYE

JONAS S. FRIEDENWALD, M.D., F.A.C.S., BALTIMORE, MARYLAND
From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital

MALIGNANT tumors of the eye form a very small fraction of the clinical material of a practising ophthalmologist. While we have all seen cases of successful extirpation of malignant tumors of various types in this domain, the statistics of the surgical results obtained by any single operator or institution would be most inadequate for the purposes of this symposium. In answering your chairman's request, therefore, I appealed to Major P. E. McNabb, the curator of the Army Medical Museum for data available in the Division of Ophthalmic Pathology which is conducted under his direction, and under the joint auspices of the three national associations of ophthalmologists. I am deeply indebted to Major McNabb for the data which are presented in tabular form below (Table I).

In reviewing these figures certain facts of interest may be mentioned. The high percentage of cures among cases of carcinoma of the lids and conjunctiva is not surprising. The majority of these belong to the group of basal cell carcinoma of low malignancy but of great local destructive power. Occurring in or near the eye, they usually come to operation at an early stage.

More significant are the 50 per cent cures found among the retinoblastomata. It is to be noted that, in this group, there was recovery in all those cases in which the eye was removed before extrabulbar extension had taken place. It is in relation to this group of cases that an improved awareness of the benefits of surgical treatment and of early diagnosis could be most useful.

Perhaps the most surprising aspect of these figures is to be found in relation to the malignant melanomata, tumors generally regarded as the most malignant of all malignant growths. Even more significant is the fact that of the 18 of these cases in which enucleation was performed before extrabulbar extension had occurred 11, or 61 per cent, survived for 5 years or more. Here again we have evidence of the importance of early diagnosis and treatment. Not all these can be counted as permanent cures, for it is well known that late development of metastatic growths, 5, 10, even 20 years, after the removal of the primary growth may occur in these cases. Perhaps it may be not inappropriate to ask the distinguished group of surgeons here assembled what they consider may be the possible factors which hold the metastatic growths in abeyance during these long periods, or what may be the factors which release their growth again in malignant development. If we knew the answers to these questions, we might be a great deal nearer to the control of this terrible disease.

TABLE I

Tumor	Number of cases	Number with local recurrences	Dead from metastasis or other tumors	Dead from causes unknown	Dead from other causes	Living and well 5 years
Carcinoma of lids and conjunctiva	5	2	1	0	1	3
Per cent		40	20	0	20	60
Retinoblastoma	14	4	6	1	0	7
Per cent		28	43	7	0	50
Malignant melanoma	33	1	12	1	6	11
Per cent		3	36	3	18	33

SUMMARY OF SIXTY-FIVE "CURES" OF CANCER ABOUT THE MOUTH

V. P. BLAIR, M.D., F.A.C.S., St. Louis, Missouri
From the Department of Surgery, Washington University School of Medicine

In responding to the request for a summary of our 5 year "cures" of true carcinoma of the mouth and contiguous tissues, we have tabulated all traced cases of true cancer (basal cell excluded) treated by us between 1915 and 1928, which are known to have been alive and apparently free of recurrence more than 4½ years after treatment of the primary growth. We have also attempted to convey some idea of the extent of the growths and, with some hesitancy, our interpretation of the cell differentiation.

Fifty-five of the patients are from a series of cases reported previously and represent about 25 per cent of the total. In this series early growths were but 4.7 per cent, medium, 16.6 per cent, advanced, 55.5 per cent; 23.2 per cent were inoperable so that this 55 might be considered as 33.3 per cent of those originally presenting any possible chance of cure.

The relative discrepancy between the stage of advancement and the number of "cures" as shown in Column A of Table I is explained by the predominance of advanced cases in the series. Over 65 per cent were classified as advanced or inoperable.

Column B, Table I shows a more definite proportion between cell differentiation and "cures," and Column C shows a striking relation between "cures" and lack of demonstrable gland involvement. However, there are enough cases with undifferentiated gland metastases that have gone 5 years without recurrence to show that even this extent of growth may not be a hopeless condition.

Table II indicates the type of treatment, which, by preference, was gross destruction of the primary area, followed by radical neck dissection in every case in which that was practicable.

Since 1928 our proportion of supposed "cures" from radiation has very definitely increased.

TABLE I

A. Stage of primary growth			B. Microscopic grading				C. Glands Microscopic grading				
Early	Medium	Advanced	1	2	3	4	0	1	2	3	4
5	26	34	16	20	11	9	21	1	4	7	4

TABLE II.—TREATMENT

Treatment	Cases
Radical operation primary growth	14
Radical operation primary growth and neck dissection	39
Radical operation primary growth and radiation	9
Radiation primary growth and neck dissection	3

TABLE III.—NUMBER OF YEARS WELL

Alive and well, years	Cases	Alive and well, years	Cases
4½	4	10	2
5	10	12	5
6	2	13	3
7	9	15	4
8	6	16	2
9	15	17	3

FIVE YEAR CURES IN CANCER OF THE MOUTH, LIP, NOSE, ETC.

FERRIS SMITH, M.D., F.A.C.S., GRAND RAPIDS, MICHIGAN

THE cases presented represent well developed or extensive lesions in most instances previously treated with escharotics or radiation.

2. The early, superficial basal cell lesions treated with radium are omitted.

3. Seven cases, not included in this report, with squamous cell lesions, lived beyond 5 years but died later of secondary lesions.

4. Our experience leads us to believe that radium has only occasional value in squamous cell lesions and that coagulation in association with mass removal of the involved area, produces the best result.

5. The prime purpose of management is elimination of the lesion. Restoration of function and appearance demand proper consideration.

TABLE I.—SUMMARY OF RESULTS

Name	Sex	Age	Location	Type	Glands	Local invasion, metastases	Operation	Method
T.D.	M	48	Lip, lower	Squamous Broder No. II No. 27500	+	+	5-12-27 5-20-27	Excision. Block dissection. X-ray
C.M.	M	39	Lip, half upper	Squamous Broder No. II No. 26933	+	—	11- 4-26	Excision. Radiation
A.C.	M	58	Lip, half upper	Squamous Broder No. II	o	+	9-28-19	Excision. Radiation
J.H.	M	55	Cheek	Squamous Broder No. I No. 26635	o	+	8- 4-26	Excision. Radiation
N.M.	F	65	Antrum, alveolus, cheek	Squamous Broder No. IV No. 25888	o	+	9-16-25	Coagulation. Excision. Radiation
W.S.	M	68	Velum, cheek	Squamous Broder No. III No. 26949	+	+	11- 8-26	Radium. Coagulation. Block dissection neck
H.W.	M	50	Tonsil, tongue	Squamous Broder No. I No. 310911	+	+	2-26-23	Radium. Excision. Block dissection
S.B.	F	50	Cheek, palate, velum	Squamous Broder No. I No. 27376	+	+	4-13-27 4-25-27	Block dissection. Diathermy. Coagulation of lesion
R.E.	M	57	Mandible, cheek	Squamous Broder No. I No. 26767	+	+	10-16-26 1- 4-27	Excision. Radiation
H.B.	M	53	Inner canthus, nose	Basal cell	o	—	4- 9-26	Radium. Excision
E.E.	M	31	Nasal ala	Basal cell	o	o	11- 5-25	Excision
K.P.	M	50	Nasal ala	Squamous Broder No. III	o	—	8-15-19	Excision. Cautery
W.C.	M	62	Eyelid, lower	Basal cell	o	—	1-11-27	Excision. Graft
H.G.	M	48	Face	Squamous Broder No. III No. 27420	+	+	2- 9-27 2-23-27	Coagulation. Excision. Block dissection
N.B.	M	59	Larynx, cord	Squamous Broder No. I No. 1665	o	+	Orig. Oct. '14. Secondary Apr. '23	Excision. Radiation

Fig. 1.

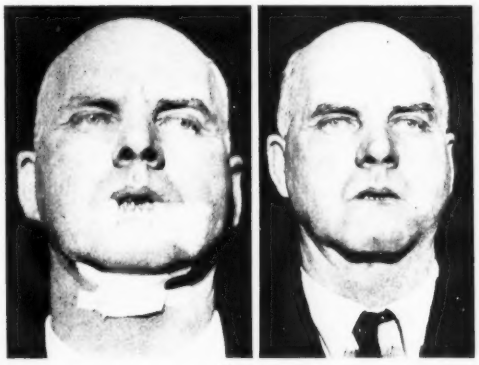


Fig. 2.

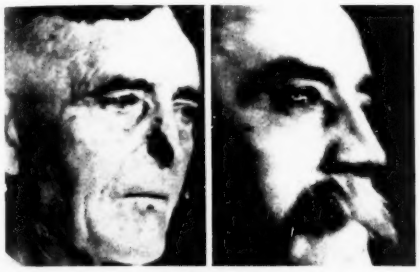


Fig. 3.

Fig. 4.

Fig. 5.

Fig. 1. Squamous cell carcinoma of the upper lip. Excision of two-thirds of the upper lip. At right, appearance 6 years later.

Fig. 2. Squamous cell carcinoma of the lower lip. Dissection of digastric and submental triangles. Excision of the entire lower lip. Result after reconstruction of the lip.

Fig. 3. Squamous cell carcinoma of the nose. Excision with cautery. Result after reconstruction.

Fig. 4. Squamous cell carcinoma. Coagulation. Excision. Block dissection of the neck. Skin graft repair.

Fig. 5. Squamous cell carcinoma of mandible and cheek. Excision of the jaw. Block dissection. Radiation.

CANCER OF THE SKIN

ERWIN P. ZEISLER, M.D., CHICAGO

PRECANCEROUS LESIONS

IN this report an attempt will be made to present a statistical study of 500 unselected malignant new-growths of the skin that were treated in private practice in the years 1914 to 1930, inclusive. Personal observation and a review of the literature lends support to the belief that cancer of the skin is not on the increase, that patients have become educated to apply for treatment earlier in the course of the disease and that more effective methods of prophylaxis and treatment are available. As long as the cause of cancer of the skin is not known, outside of the rôle of heredity and the congenital inherent tendency observed in that rare condition known as xeroderma pigmentosum, it is important to recognize such factors as may produce long continued irritation as exciting causes. Among these are mechanical, chemical, and actinic stimuli, especially overexposure to wind and sunlight, occupational hazards in which arsenic, tar, pitch, paraffin, and radio-active substances act as carcinogenic factors, and finally the changes in the senile skin that predispose to malignancy. It is well known that an epithelioma seldom develops from a normal skin. The only effective preventive that we possess is a careful clinical, histological, and morphological study of the so called "precancerous" dermatoses and their eradication. The more important precancerous lesions that demand attention are; (1) the senile keratoses which occur so frequently in elderly people on the exposed surfaces and which are known to develop into either basal or squamous types of epithelioma —seborrhœic keratoses much less frequently undergo malignant degeneration; (2) leucoplakia with its associated etiological factors, tobacco and syphilis; (3) roentgen and radium keratoses and chronic radiodermatitis; (4) the scars of lupus vulgaris; and (5) certain nævi especially the black or blue-black pigmented moles and the hyperpigmented lentigines of the aged from which may develop the most malignant type of cutaneous neoplasm, the melanocarcinoma. Paget's disease and Bowen's disease were formerly considered to be precancerous but are now known to be cancerous at their onset.

CLASSIFICATION OF EPITHELIOMATA

Prompt recognition of early lesions is as important in cancer of the skin as it is in cancer elsewhere. A biopsy should be done if possible in all cases to determine the degree of malignancy and the probable radiosensitivity. The dangers of a biopsy have been overemphasized. By far the largest number of skin cancers about the face will be found to be of the basal cell type, also classified as non-epidermoid or rodent ulcers. The slow growth, low degree of malignancy, absence of metastases, and relative radiosensitivity gives a favorable prognosis in at least 90 to 95 per cent of these cases. Failures in our experience have occurred in less than 5 per cent and can be attributed to invasion of the deeper tissues such as periosteum, cartilage and bone, to inadequate treatment or negligence on the part of the patient. Squamous cell, prickle cell, or epidermoid cancers of the skin are much more dangerous, are characterized by rapid growth, early invasion of the deeper tissues, a tendency to early metastases and are more difficult to cure, although Regaud has shown that the radiosensitivity is the same for both forms of skin cancer. Practically all cancers of the lip, buccal mucosa, floor of the mouth, tongue, and penis are of this type. In addition the carcinomata that develop on the site of a preceding radiodermatitis, in the scars of lupus vulgaris, and most of those of the extremities, belong in this group. An experienced dermatologist will, as a rule, have no difficulty in distinguishing a basal from a squamous lesion clinically but surprising variations in histological structure are often encountered when a biopsy is done. Another intermediate group, the basal-squamous type, has recently received careful study, and it has been shown that lesions apparently of the basal type that metastasize belong in this group. Finally, there are a group of rare cases of multiple benign superficial epithelioma, either basocellular or prickle cell, or mixed, which can be differentiated histologically and clinically from Bowen's intra-epidermic carcinoma and the so called extramammary Paget's disease.

METHODS OF TREATMENT

Cancer of the skin, on account of its accessibility and the readiness with which it can be recognized, lends itself peculiarly to successful treatment by surgery, chemical and electrical cauterization, and roentgen and radium therapy. In deciding on the best procedure to employ, it is essential to consider the type of lesion, es-

TABLE I.—CLASSIFICATION OF 500 MALIGNANT NEW-GROWTHS OF THE SKIN

Basal cell epitheliomata	
Early superficial nodular or ulcerative	320
Advanced infiltrating deep seated types	36
Total basal cell epitheliomata	356
Squamous cell epitheliomata	
Early superficial	74
Infiltrating deep seated	28
Total squamous cell epitheliomata	102
Advanced epitheliomata, not treated or receiving palliative treatment	13
Basal-squamous cell epitheliomata	3
Malignant melanoma	7
Paget's disease	5
Bowen's disease (intra epidermal epithelioma)	2
Sarcoma, sarcomatosis	12
Total	500

TABLE II.—CLASSIFICATION OF FOUR HUNDRED AND SIXTY-ONE EPITHELIOMATA, ALL TYPES, ACCORDING TO LOCATION

Location	Cases
Nose	117
Cheek	106
Canthi and lids	65
Forehead	54
Lips	34
Tongue and mouth	21
Extremities	18
Ear	17
Neck	11
Trunk	9
Scalp	5
Chin	4
Total	461

TABLE III.—CLASSIFICATION OF EPITHELIOMATA ACCORDING TO AGE

Age in years	Cases
10 to 20	0
21 to 30	11
31 to 40	34
41 to 50	110
51 to 60	123
61 to 70	115
71 to 80	56
81 to 90	12
Total	461

pecially its depth, extent, mobility and the anatomical location. The duration, the histology, probable radiosensitivity, and the effect of previous treatment are also of importance. The underlying principle of all forms of treatment is the destruction or radical removal of the cancer cell. Surgical excision will cure permanently many selected cases of epithelioma but in certain locations such as the nose or eyelids may be impractical. Equally favorable statistics can be presented by the advocates of modern roentgen and radium therapy. In our own practice we have employed at various times all the recognized methods of treatment and have not relied on any one single procedure. It is only natural that in a 20 year period considerable variation in prevailing modes of treatment should have occurred. In basal cell lesions we prefer to do, whenever possible, a preliminary thorough curettage under local anæsthesia followed by cauterization of the base with acid nitrate of mercury (liquor hydrargyri nitratis) after the well known method of Sherwell. This is invariably supplemented by intensive roentgen or radium therapy, although in recent years we have relied mainly on the latter. The cosmetic results are excellent and we have encountered no complications even in deep seated lesions about the eyes or ears. When cartilage or bone is involved either surgery, cautery removal or electrocoagulation is advised rather than radiotherapy. In squamous cell epitheliomata, particularly early lesions of the lips, face, or extremities, our preference has been for a preliminary destruction with the electrocautery followed by radium therapy. Patients in whom the glands were involved at the time of examination were not treated and are not included in our series as it has been our principle to refer these patients for surgical treatment.

Whether prophylactic radiation or a surgical dissection of uninvolved glands is advisable as a preventive measure is a debatable question. It has also been our experience that all roentgen and lupus carcinomata should be treated surgically, or with the high frequency knife with subsequent plastic repair when necessary. Recurring cases of squamous carcinoma of the skin are treated with bipolar electrocoagulation or by interstitial platinum radium needles containing 1 or 2 milligrams of radium element inserted for 24 hours or longer. Suitable lesions of the tongue and buccal mucosa were formerly treated with gold radon seeds, although we have records of several cases of cure with surgical diathermy without radium. At the present time we prefer the method of radium puncture used at the Curie institute, enough 1 and 2 milligram needles being sutured in the tongue to give the necessary radiation dose in 7 days, with due regard for the complications that may arise in the course of the treatment.

Radium therapy. The technique of radium therapy in skin epitheliomata will naturally vary

TABLE IV.—CLASSIFICATION OF EPITHELIOMATA ACCORDING TO SEX

	Cases	Per cent
Males	253	55
Females	208	45

TABLE V.—CLASSIFICATION OF EPITHELIOMATA ACCORDING TO NUMBER OF LESIONS

Single	413
Multiple	48
Total	461

TABLE VI.—METHODS OF TREATMENT EMPLOYED IN FOUR HUNDRED AND SIXTY-ONE EPITHELIOMATA, ALL TYPES

Methods of treatment	Cases	Failures
Curettage with cauterization and fractional doses of X-ray (Old technique prior to 1920.)	85	11
Curettage with cauterization and massive doses of X-ray	65	3
Curettage with cauterization and radium	138	2
Electrocautery with radium	84	0
Bipolar electrocoagulation (Surgical diathermy)	8	3
Surgery (Alone or with irradiation)	10	4
Radium alone	30	1
Radium interstitial	15	9
X-ray alone	26	3
Total	461	36

with the amount of radium at the disposal of the operator. For the majority of superficial lesions following curetting and cauterization, we have found that surface contact applications with lightly screened, full strength, flat glazed applicators to be sufficiently accurate and effective. For more deep seated and extensive cases, radiation is used at a distance of 1 centimeter with molds or blocks of tubes screened with 0.5 millimeter gold and 1.0 millimeter rubber, the dose being 50 to 60 millicurie hours per tube figured on the basis of approximately 1 tube for each square centimeter. The entire dose may be given in a single treatment or over a period of four successive days after Regaud's method. In the tumor clinic of the Michael Reese hospital at the present time the Curie technique is being carried out with excellent results. Individual molds of Columbia paste are prepared for each patient and 5 or 10 milligram tubes are attached on the outer surface of the mold permitting uniform and accurate radiation. This technique is especially suitable for lesions around the eyes and for lip cases.

Roentgen therapy. The technique of roentgen therapy in our hands has also changed. Up to 1920 we used the old method of fractional irradiation of Schiff and Freund, coils and gas tubes being used. Whereas this method was apparently fractional the actual result was to give an erythema dose within a short period, and therefore it was in effect an intensive treatment. Since 1920 we have used the standardized MacKee method of hyperintensive or massive dose radiation, 2 or 3 times the erythema dose being given in a single treatment or the dose being divided over several applications with a potential of 100,000 volts and no filter. The percentage of primary cures has not been markedly increased but there have been fewer recurrences and a decided saving of time. Roentgen therapy is of course also of great value as a postoperative treatment.

TABLE VII.—CAUSES OF FAILURES IN 36 CASES TERMINATING FATALLY

	Cases
Too advanced	13
Cartilage and bone involvement	8
Early metastases	8
Late recurrence (neglected to return for treatment)	3
Previous surgery and radiation (radio-resistant)	5
Insufficient treatment	2
Apparently favorable cases	2

ANALYSIS OF CASES

Among the 500 malignant new-growths of the skin, 356 were classified as basal cell epitheliomata, of which 320 were early superficial nodular or nodulo-ulcerative types and 36 were deep seated and infiltrating. Six cases were so far advanced when first seen that they were considered hopeless and were not treated or received only palliative treatment. Eight cases were classified as failures and eventually died of the disease and 30 recurrences were observed mostly during the first year, all except 2 of which yielded to further treatment by cautery, radiation, or surgery. Three cases are known to have succumbed to late recurrences at an advanced age. Therefore, there were in these 356 cases, 310 primary clinical cures (87 per cent) and 19 failures (6 per cent). If we include the recurring cases cured by further treatment the percentage of cures would be close to 94. However, 58 cases did not remain under observation longer than 3 to 6 months and the percentage of 1 to 5 year cures therefore cannot be estimated as higher than 70 per cent. Many patients treated 15 or 20 years ago are known to have died of other causes and an attempt to follow up cases not heard from for years has been found to be unproductive of results. We have had great difficulty in having patients come in for observation at regular intervals for a 5 year period after

TABLE VIII.—SARCOMATA AND MELANOMATA

	Cases	Clinical cures (1 to 5 years)	Failures
Melanocarcinoma	7	0	7
Localized sarcomata	6	5	1
Sarcoma generalized metastatic.	5	0	5
Kaposi's sarcoma	1	0	1

they have been clinically cured. Another important point to remember is the tendency in elderly patients to develop multiple successive epitheliomata in different locations. We have several patients followed for 5 to 20 years who belong in this group. For example an elderly woman of 61 was treated in 1913 for an extensive rodent ulcer of the temple which was cured and remained permanently well. During the next 20 years she was cured of at least a dozen basal lesions but eventually died at the age of 81 of a basal-squamous carcinoma of the cheek which recurred after treatment by surgical diathermy and radium and metastasized to the cervical glands. From the standpoint of a 5 year cure, the lesion on the temple might have been considered a success but we have included these cases among the failures. Another woman of 77 was cured in 1914 of a large, flat rodent ulcer of the forehead and a basal lesion of the inner canthus. Numerous epitheliomata were successfully treated in the next 14 years, but she finally died at the age of 91 with a resistant squamous lesion of the cheek.

Of 102 squamous epitheliomata 74 were early superficial and 28 infiltrating and deep seated. Seven cases were so advanced that only palliative measures were advised. Twenty one involved the tongue and buccal mucosa with 14 failures. Of the remaining 81 cases including 34 lip cases, there were 12 failures including recurring cases, of which 9 were fatal. The percentage of clinical cures was therefore about 71, and if we deduct 20 cases that were not followed the percentage of 1 to 5 year cures drops to 51. If we were to omit the intra-oral cases which had a mortality of 66 per cent the percentage of cures would be much higher. In this series of cases were 6 advanced cases of lupus carcinoma, 3 roentgen carcinomata, 3 carcinomata of the extremities that became metastatic, and other cases which had been ineffectually treated by surgery, radiation, pastes, etc., and had become radioresistant.

TABLE IX.—SUMMARY OF RESULTS OF TREATMENT IN FOUR HUNDRED AND SIXTY-ONE EPITHELIOMATA, ALL TYPES

	Cases	Per cent
Basal cell epitheliomata	359	
Clinical cures, 1 to 5 years	252	70
Clinical cures not followed	58	16
Recurring, cured by further treatment.	30	8
Total clinical cures	340	94
Hopeless cases (No treatment or palliation)	6	6
Failures (Late recurrences, fatal cases).	13	
Total	359	
Squamous cell epitheliomata (including 21 tongue and intra-oral cases and 34 lip cases)	102	
Clinical cures, 1 to 5 years	49	48
Clinical cures not followed	20	20
Recurring, cured by further treatment.	3	3
Total clinical cures	72	71
Hopeless cases (no treatment or palliation)	7	29
Failures (late recurrences, fatal cases).	23	
Total	102	

We have had no cures in 7 cases of melanocarcinoma and have seen only disastrous results from surgery. It is our impression that these patients will live longer if they are left alone. The treatment of localized sarcomata by combined surgery and irradiation was successful in 5 cases.

CONCLUSIONS

In conclusion we feel that the treatment of cancer of the skin must be individualized, must be based on a thorough knowledge of the precancerous dermatoses, and an expert appraisal of the clinical and histological features of each case. The therapeutic approach should aim to utilize all the known agents at our disposal including surgery, chemical and electrical cauterization, radium and roentgen ray. In epitheliomata of the basal cell type the percentage of cures should reach close to 95 per cent. The prognosis in squamous lesions should be more guarded.

SYMPOSIUM: TREATMENT OF FRACTURES

DEPRESSED FRACTURES OF THE SKULL

HOWARD C. NAFFZIGER, M.D., F.A.C.S., San Francisco, California

TREPHINING for depressed fractures is an operation of antiquity, but only recently has there been an experimental basis to indicate the effects arising from long continued bony depressions. Although trephining was done in ancient Egypt, and even in earlier times, the notes made by Hippocrates are among our first records of the surgery of depressed fractures. He counselled against operation and gave the sound advice that fractures with depression were not particularly dangerous unless the membranes were ruptured. The opposite view, favoring operative treatment, prevailed during Roman times and the long period in which there was little or no advance in surgical knowledge. During the Arabian ascendancy, and through the time of Roger of Salerno, the establishment of the European Universities, and the Renaissance, the same ideas prevailed in Italy, France and England. The methods of dressing and the types of local application were considered to be of great importance.

In the sixteenth, seventeenth, and eighteenth centuries, important writings are associated with the names of Ambrose Paré, Pettit, Percival Pott, John Hunter, and Larry. Abernethy, Hunter's successor, sounded a note of caution to the radical surgeon, and the nineteenth century was filled with divergent opinions. It is surprising that, before the days of antiseptic surgery, there was not a greater weight of opinion on the non-operative side. Following the period of Lister, there was more general agreement upon the desirability of elevating depressions, and, in a general way, this tendency has continued to the present.

It is a common conception that depressed fractures of the skull are responsible for a degree of generalized brain compression which is dangerous. Even more often it is said that untreated depressions cause progressive brain damage, leading to pachymeningitis, adhesions, areas of cerebral softening, and brain cysts. It is asserted frequently that depressed fractures should be elevated to prevent the later occurrence of convulsive states, mental derangement and psychoses. When such conditions are associated with the presence of a depressed fracture, surgeons are prone to attribute them to the depression and to advise that it be relieved surgically. It seems timely to consider the results of this policy, for surgeons of experience have become aware that operations in such conditions do not yield brilliant results and usually are fruitless.

It may be said at the outset that the governing principles in the management of *any* depressed fracture should be, first, to prevent infection, and second, to minimize the amount of brain scar and the number of sequelæ resulting from scar and adhesions.

The factors which come into play when a depressed fracture is produced must be distinguished clearly. Depressed fractures of the skull, without dural laceration, may be associated with varying degrees of brain injury. These will be considered in one group. Depressed fractures of the skull with penetration of the membranes inevitably lead to brain damage, also of varying degrees. These will be discussed separately.

Let us first consider those depressions which have not penetrated the dura. It is customary to elevate such depressions when they are seen shortly after injury; for patients with depressions of long standing, also, this is the usual advice. If one has operated upon many persons with depressed fractures of long standing, and has opened the previously unpenetrated dura to inspect the condition of the underlying brain, he cannot fail to be impressed by the number of instances in which an apparently normal brain is uncovered, even though the depression has been present for years. Obviously this is not always true, and a yellow or degenerated cortex may be seen. The point of particular interest is that this is not invariable.

Questions immediately arise: Is a continued depression harmful? Does such a depression produce changes in the underlying brain by its mere presence, or is the brain change seen beneath certain of the depressed fractures caused by the

injury itself, without reference to the continuance of the depression?

The desire to solve these two questions led us to undertake certain experimental work on animals, some time ago. This work has been reported previously.[1] The experiments showed clearly that a depressed fracture, caused by striking a blow, produced both early and late pathological changes. Depressed fracture produced by pressure alone did not cause such changes. These depressions, produced by the insertion of smooth foreign bodies into the skull, caused no changes other than some condensation of the brain tissue beneath them, nor was there any difference in the microscopic findings in the brains of animals sacrificed in 2 days after the depression had been introduced, and those killed much later. If the foreign bodies were removed, later examination showed a rapid restoration of the contour of the brain and there was no evidence of a condensation of brain tissue at the location of the previous pit. Following the production of depressed areas by slow, localized compression, neither pachymeningitis, leptomeningitis, adhesions, softening, nor cysts were produced.

Our final conclusions were that, in cases of depressed, non-penetrating fracture of the skull, the changes in the brain are caused by the force producing the injury rather than by the depression of the bone. Pathological changes in the brain appear to be more marked in the early and in the late stages than they do during the intermediate period; they are chiefly subcortical. Depressions of moderate size cause no pathological changes in the underlying meninges and brain.

If, for the time being, we consider only those depressed fractures in which there has been no dural injury, the question arises: Should such depressions be elevated? If this inquiry is examined in relation to the production of late changes in the brain, there seems to be very little reason for the operation. Likewise, there can be little sound basis for the argument that encroachment upon the intracranial chamber by reason of the depression, is sufficient to cause *generalized* signs of brain compression. If generalized brain compression is present, it results from other factors, such as free hæmorrhage. For the comparatively slight encroachment of a bone depression into the intracranial chamber, displacement of blood in the vessels and absorption of cerebrospinal fluid permit adequate compensation. Certainly there is no urgent reason for the elevation of a depression because of a conception that the depression itself is causing generalized intracranial pressure.

Another point may be raised: If a depression remains, may it be a source of mechanical irritation to the underlying brain, by reason of the projection into the dura which it causes, even though it does not produce degenerative changes in the brain? This is quite possible, and we should hesitate to advise against the elevation of smooth depressions, even if we were sure that the dura had not been penetrated. However, we feel safe in saying that, in the presence of a depression without laceration of the dura, the immediate operations which are conducted so often, frequently with the patient in a precarious condition, are not justified. In such instances one too often sees a patient brought into the hospital in a condition of shock, transferred from an ambulance to an examining table, changed again to a stretcher and transported to an X-ray laboratory where he is moved back and forth in the process of taking pictures; then he is hurried to an operating room and an emergency operation is performed. Frequently little consideration is given to the advisability of using local anæsthesia, and the general condition of the patient is such that a hurriedly planned procedure is done. Less than the usual painstaking care is exercised, and less attention is given to details; there is more hæmorrhage, at a time when the patient can ill afford to lose the blood, than would have been the case with a more orderly preparation, after the patient had recovered from shock.

The character of the treatment and the time it is instituted depend upon the condition of the patient and the presence or absence of an open wound. In a closed, depressed, non-penetrating fracture, the time of operation is elective. Each case requires individual judgment. The only part of the treatment that is urgent is the prevention or control of infection. In some instances this involves relief of the depression; in others, it may await a later attack. When the depression is elevated, the bone should be replaced so that no permanent defect will remain.

Determination of dural penetration usually is made by roentgen examination, but this is not so urgent that it needs to be done during the period of shock. One point in X-ray examinations is overlooked so frequently as to merit comment. It is customary to make the diagnosis from films showing anteroposterior and lateral views of the skull. All the details of a depression and its depth cannot be judged from these. Views should be requested which show the exact area of depression in true profile. To obtain these, the rays between

[1] Naffziger, Howard C., and Glaser, Mark A. An experimental study of the effects of depressed fractures of the skull. Surg., Gynec. & Obst., 1920, li, 17–30.

the tube and the film should be exactly tangential to the area in question.

If we turn now to a consideration of the instances of depressed fracture with penetration of fragments through the dura and into the brain, a much more serious situation confronts us. A large proportion of these fractures are open, and the additional hazard of infection of the nervous system enters our calculation.

In the management of such injuries, the presence or absence of an open wound and the length of time between the injury and the surgeon's repair bring in factors which can be judged wisely only by a competent surgeon at the time the patient is seen. Under ideal conditions, thorough surgical repair under local anæsthesia, with careful débridement of the scalp and other devitalized tissues, is desirable. In cases of open fracture, such treatments cannot be deferred very long. In dealing with a closed fracture, even if there is laceration and penetration of the dura by fragments, there is more latitude of action. Frequently, when the general condition of the patient is poor, postponement of such an operation for several hours or even for a day or two, is a matter of good surgical judgment.

Wagstaffe's follow-up of 280 patients with penetrating wounds of the dura showed that convulsive states followed in 18.7 per cent of them. In non-penetrating wounds, the incidence of fits was only 1.6 per cent.

In the light of our present knowledge of post traumatic convulsive states, our best opportunity of benefiting the patient lies in such careful repair that a minimal amount of scar tissue results.

In such surgical repair of penetrating injuries, a point that I wish to stress especially is the desirability of thorough removal of all devitalized brain tissue, and of such additional tissue as has been contused sufficiently to indicate that its organization and repair will lead to a considerable cicatrix. After the removal of foreign bodies, the sucking out of devitalized brain and the tying of small cortical vessels in the region, with resection of contused surfaces, will be repaid by lessening of the subsequent scar, adhesions and contraction of the area, and consequent lessening of distortion and deformity of the surrounding brain and ventricles which they cause.

Following the removal of loose penetrating fragments, and of the devitalized area of brain, the importance of dural repair should be stressed. This is not always easy, and extensive dural lacerations frequently demand that some new tissue be grafted in to fill the defect. Minor dural lacerations ordinarily can be closed with fine needles and silk. The larger lacerations may require the use of a bit of tissue from the temporal fascia or the pericranium, to give a smooth covering. Failure to make such a complete dural closure may be justified at times, for instance when one is dealing with an open fracture, especially when the operation is performed some time after the injury, and there is evidence of infection. Such a set of circumstances is, however, very unusual, and, in the earlier cases of both open and closed fractures, dural repair should be the rule. When such closure is not made, complications are frequent. Occasionally protrusions of the brain through the opening will occur; a considerable extrusion beneath the scalp may ensue, and ultimately there is likely to be a fungus, with the attendant difficulties of long-continued dressings and delayed healing, or death may occur as a result of the rupture of a ventricle, an abscess, or meningitis. Such protrusion of brain through a dural defect is, of course, particularly likely to occur when there has been widespread brain contusion and resulting edema.

Skull defects may be avoided by replacement of the bone, following the repair of the brain and dural injuries. Such replacement is desirable whenever possible.

CONCLUSION

There is experimental and clinical evidence to indicate that a depressed fracture of the skull is not so harmful as has been considered generally. The trauma producing the depression causes the damage to the brain. Our efforts must be directed toward lessening the risk of infection, toward diminishing scar tissue formation in the brain, and toward avoiding skull defects as far as it is possible to do so.

THE EXACT RÔLE OF PHYSICAL THERAPY IN THE TREATMENT OF FRACTURES[1]

CLAY RAY MURRAY, M.D., F.A.C.S., NEW YORK
Assistant Professor of Surgery, College of Physicians and Surgeons, Columbia University; Associate Attending Surgeon, Presbyterian Hospital in the City of New York

THERE is today in the minds of many the impression that the net result of the use of physical therapy in the treatment of fractures is to prolong the patient's convalescence. Whether or not this be universally true, the fact is that it is true often enough to warrant serious consideration of the real value, if any, of physical therapy in this field, and the proper rationale in its use if it is to be used.

In order to evaluate the exact rôle of physical therapy in the treatment of fractures, it is essential that we first lay down the rationale which should govern all fracture treatment.

Our aim in fracture treatment is to restore a given individual to his normal habit of work or play as soon after his injury as possible, and in as nearly normal an anatomical and physiological state as possible. Broadly, this may be said to be our aim in the treatment of any human ill. But in the treatment of injury we face a problem with which we are not often forced to deal consciously in disease. That problem is the necessity of the patient's co-operation in the treatment if it is to be successful either in its final aims, or in the time taken to accomplish them. In a case of pneumonia or of appendicitis the patient is a relatively passive agent, and resumption of function in the affected organs depends largely upon automatic mechanisms independent of the patient's active efforts. In a fracture, on the other hand, though we may make the bone straight and hold it so until it has healed, the only mechanism whereby the normal use and activity of the part may be rapidly regained, whereby the strength and suppleness of the part may be restored, is the active, voluntary use of the part by the patient. In any group of cases, the question of whether or not we get rapid functional return in any given case depends, all other factors being equal, almost entirely upon how early we get this active functional exercise on the part of the patient, and upon how generous he is with his efforts. To a larger extent than is commonly appreciated the functional end-result is also dependent upon these same factors. It may be stated categorically that prolonged and slow functional recoveries are prone to be less complete than those that are relatively rapidly accomplished.

The ideal fracture treatment would be to "wish" the bone fragments into place, with the abolition of all pathology, and to hold them by force of will until the fracture was healed, while the patient went about his normal life without interruption. Translated into clinical terms this means reduction with as little attendant violence and damage as possible, early abolition of as much pathology as possible, as little interference on our part with function as possible during the bone healing process, and as much functional activity as possible on the part of the patient. In any given case that method of treatment is best which can with safety most nearly fulfill these requirements.

It is obvious, if we grant the validity of the preceding analysis, that any given procedure can be of value only in so far as it aids in the accomplishment of one or more of these general aims of treatment. To assign to physical therapy any exact rôle in the treatment of fractures it is obviously necessary to be able to state what effects it can produce, where those effects may be of value, and how they may be best elicited, i.e., what methods of physical therapy are best employed.

First let us consider what effects physical therapy can be justly assumed to produce. I express a personal opinion, although I am certain that it is held by many others who have watched the development of the treatment of fractures, when I say that much has been said and written of the mode of action of various physical therapeutic agents that is unfounded in fact and without other reason than unsupported theory or vivid imagination. I believe, however, that we *know* that physical therapy can accomplish certain things, *if properly and intelligently applied.* It can relax muscle spasm; it can relax vascular spasm. I feel that our certain knowledge stops there. There are obvious secondary results of these two actions which we must logically recognize. Relief of pain and soreness, increased blood vascular and lymphatic circulatory efficiency, increased local metabolic activity are natural and undeniable consequences. I believe that these are the only effects which we are justified in depending upon in fracture treatment, with one excep-

[1] From the Fracture Service of the Presbyterian Hospital in the City of New York.

tion which I shall mention later. How are these effects accomplished? There is again, in so far as I can see, no need to go far afield for abstruse explanations. There is no justification, and indeed no need, for talk about a little understood electrical force applied in the form of the static brush "pushing and forcing exudate out of the tissues"; or of the part played by the electrical nature of diathermic heat in the production of its effects.

If one stops for a moment to consider the wonderful character of the human neuro-muscular and neuro-vascular reflex mechanisms, and of their activation by sensory impulses of a wide variety, central as well as peripheral, one can readily realize that the sensory effect of any given agent can well be responsible for resulting relaxation of both muscle and vascular spasm. And it is purely upon these two effects of physical therapy that we can depend for help in the treatment of fractures. The one exception to this statement lies in the use of muscle stimulation. There have been in use for many years various modifications of the electrical current for its effect in the production of muscle contractions. The earlier forms, in which both faradism and galvanism were used, produced muscle spasm rather than a normal muscle contraction, and constituted therefore a handicap rather than a benefit. There have been developed, however, through the use of rapidly interrupted galvanism associated with a surge variation, apparatuses which can approximate the normal muscle wave of contraction and relaxation without spasm, although they can never equal the human mechanism in efficiency. One may consider this as a possible substitute, imperfect to be sure, for voluntary muscular activity by the patient in evaluating physical therapy in fracture treatment.

We may say that there are three elementary and basic forms of physical therapy available in fracture treatment: heat, massage, and muscle exercise. The first two are dependent for their effects on the relaxation of muscular and vascular spasm, and their action is wholly through the sensory arc of a reflex mechanism; it depends almost entirely on the pleasurable sensory effects produced. The third is of value largely for its pumping effect on the lymphatic and venous circulatory mechanism of the part as a whole, and in part for the artificial functional activity which results from its use. To these may be added the factor of moderate elevation as a circulatory aid. This elevation depends for its effect on gravity, and it must not be of sufficient degree to interfere through this factor with the arterial inflow to the part. It should merely be sufficient to aid the lymphatic and venous drainage from the part.

The minute that one of these procedures causes pain or discomfort it ceases to be of value, and becomes a liability rather than an asset since it produces the very things we are trying to avoid—muscle spasm and vascular spasm. Heat is best applied therefore in an intensity low enough to produce merely the pleasurable effects of heat. Reddening of the skin is no criterion of the effect of heat. Tle patient's sensations are the only reliable criterion for intensity and length of treatment. Massage produces its effects through the pleasurable sensation it gives, and not through the force with which it is applied. Its results are due to relaxation of spasm and not to any mechanical milking or violent stimulation of the part. The gentler it is, the more regular it is; the slower it is, the more uniform it is in force and direction; the more pleasurable the feeling, the more marked the relaxation of spasm. The stimulation of muscular contraction can be of no use if it is characterized by spasm, if it causes discomfort or actual pain, or if it is carried on to the point of fatigue. Nor can it ever be of as much value as the patient's voluntary exercise of the same muscle.

There have been developed thousands of pieces of apparatus designed to cure the patient through the exercise of physical therapy. None of them is capable of doing more than evoking the mechanisms which I have cited. None of them is capable of accomplishing more in the way of relaxation of muscle and vascular spasm than is the use of heat and massage such as I have described, coupled with moderate elevation, competently and carefully carried out. Apparatus may spare the time and energy of the doctor, may be made to replace lack of skill or practice on his part, may make it possible to take care of more people in a given time, may exert some effect psychologically on the patient—good or bad—but it cannot accomplish anything which the doctor himself is incapable of accomplishing, nor can it work through any other mechanism than that which I have described. A proper apparatus *can* offer a relatively inefficient substitute for the patient's voluntary muscular activity when it is either impossible or unsafe to secure voluntary active function. Any piece of apparatus, any so called modality, is of value only in so far as it makes use of these principles. The whirlpool bath combines gentle massage and pleasurable heat. The static brush should provide the effects of pleasurable massage. Diathermy should provide the reflex effects of pleasurable heat. Intense diathermy, producing all the heat the patient can stand, does harm. Intense heat of any other type does the

same thing. Vigorous massage is damaging if it gives the patient anything but pleasure. Muscle stimulation if carried to the point of spasm, discomfort, pain, or fatigue is damaging. But so is voluntary exercise of the patient if carried beyond pain limits and up to fatigue. The physiological basis of the use of all of them is identical.

Here, then, lies one reason why the use of physical therapy frequently results in the prolongation of convalescence—in the lack of appreciation of the physiological principles back of its use, and the failure to appreciate the simplicity of the mechanism involved. The fixed idea that the *physical therapist* must do something, instead of the viewpoint that his real job is merely to make it possible for *the patient to do it himself*.

Let us now take the specific phases of fracture treatment, and with this conception of physical therapy, see if and where it may be of value.

1. The reduction. The use of light stroking massage of the type described by Lucas Championnière and Mennell, or of any other agency which will produce the same results, may be of definite value immediately following the injury and up to the time of reduction in helping to minimize the exudation into, and infiltration of, the tissues and in alleviating muscle spasm. It could well be combined with emergency traction to advantage in the period of inactivity between primary splinting and reduction, if the facilities available make it possible.

2. The post reduction period. One of our objects in the treatment of a fracture is the early elimination of pathology before it can undergo organization into scar tissue. Immediately after a fracture there is hæmorrhage and exudation and cellular infiltration in and about all the structures of the affected part. This pathology undergoes organization into tissue rapidly. Within 72 hours this organization is well started and by the end of 10 to 12 days it has progressed to considerable magnitude. In the first 5 to 10 days a large proportion of this exudation and infiltration can be removed from the part, before it can undergo organization, by any mechanism which will restore the normal circulatory efficiency of the part. It is here that physical therapy can be, I believe, of definite value in itself, if the method used in the treatment of the bone lesion allows of its use. Light massage of the character already indicated, heat of the type previously described, or substitutes for them, combined with moderate elevation can do much to aid in this early elimination of pathological processes. If it can be largely eliminated, the amount of stiffness and soreness which will remain for later treatment, and the amount of late swelling on use and other circulatory handicaps due to scar tissue infiltration which will require attention, will be greatly diminished, and there will be less talk of the after treatment of fractures. To make it possible entails the use of methods of treatment for the bone lesion allowing of access to the part for physical therapy, and the training of physical therapy technicians who know what we are trying to do and are capable in these early stages of giving the treatment with safety to the patient. I have met very few who are so trained. The maximum effect of such treatment is secured in the first few days. It loses its value progressively as the days pass by. Adequately and intelligently used, I am convinced by practical experience that the convalescence time can be materially shortened. In addition, I do not doubt but that the early restoration of adequate circulatory efficiency plays a large part in influencing the healing process in bone. Strangely enough, it is in this phase of fracture treatment that physical therapy is rarely used, and the development of its use by the physical therapists has been very much neglected. And yet it is only in this phase that it can play an essential part in treatment.

If the method of treatment or the nature of the injury allows of full function during this stage there is no use or need for muscle stimulation, unless it be used as a substitute for active muscle exercise in a patient who will not give his voluntary help. If the method of treatment used is such that active motion cannot be used or is definitely limited, muscle stimulation of the proper type can help greatly as a partial substitute. I should like to stress the point that the muscle activity desired in this instance is not the subminimal invisible contraction desired in the treatment of paralytic muscle, but is the maximal contraction obtainable without spasm or discomfort, and stopped short of fatigue. It is a substitute for the patient's active use of the part. Even in the presence of circular plaster or splints its use can be managed through the windows or apertures in the apparatus.

3. After-treatment. After the bone has healed, and the patient is in position to regain progressively the full use of the part is the stage in which physical therapy is almost universally used—and abused. There are certain definite facts which must be stressed before discussing the use of physical therapy at this time. No physical therapy that I am familiar with can restore strength and suppleness to a limb, regardless of who gives it, or what complicated and impressive machinery is used to carry it out. The only factor

essential in the regaining of functional activity by a patient is the voluntary active use of the part progressively by the patient. These facts are incontrovertible. The doctor who sees the case, the technician who administers treatment, and the patient who receives it must all know this fact.

Physical therapy may be used to make it easier for the patient to do his part by temporarily ridding the part of soreness and stiffness through the mechanism already described so that it is easier for him to use the part. It may be used to get rid of the unpleasant effects of overexercise; pain, soreness, stiffness, and swelling. But it cannot successfully be used to restore, *per se*, strength and suppleness to a part. The only way to strengthen wasted muscles permanently or to limber up stiff joints permanently is for the patient actively to exercise them. Physical therapy can do no more than make the voluntary function easier and less distressing. Here lies the second reason why physical therapy so often hinders the convalescence of the patient. He does not know that the heating, the rubbing, the various complicated appliances used, cannot possibly make him well, and for week after week and month after month he sits patiently waiting for this easy and effortless recovery to take place. I know that many of the physical therapists who treat this hopeful but deluded patient are firmly convinced that they can get him well. And I have reason to believe that many of the doctors of these patients have never given a thought to what either the patient or the physical therapist know or believe. And physical therapy under such auspices becomes an idle and futile gesture, but unfortunately one in which the patient is taught to have infinite confidence.

There are here presented the grounds which exist for the belief that physical therapy can be of value in fracture treatment. The attempt has been made to show the basically simple *modus operandi* upon which all physical therapy is dependent for its effects, regardless of the complicated trappings in which it may be dressed. The attempt has been made to indicate when and how these effects may be of value. Attention has been called to defects in the present application of physical therapy to treatment of fractures which are widespread, and which serve in many instances to delay convalescence, rather than to hasten it. The solution lies in education—first of ourselves, next of our technical assistants, and lastly of our patients—to the realization that in treatment of fractures the thing that counts, apart from the actual reduction, is not what *we* can do for the patient, but what we can help the patient to do for himself.

THE SIMPLIFICATION OF THE TREATMENT OF FRACTURES

PAUL B. MAGNUSON, M.D., F.A.C.S., CHICAGO

THE simple methods which are applicable to the reduction and fixation of most fractures seem to have been pushed into the background during the last few years by the vast amount of literature advancing pet methods in operative treatment. It is true that a certain number of fractures should be recognized immediately as operative cases, but the decision as to whether or not a given fracture is operative should be made at once, and not delayed until a bad result has occurred. There are certain fundamental principles which should be kept in mind. Immediately a fracture comes to hand the structures of the anatomy involved should be visualized. Before the fracture is thought of as a pathological entity, the first step should be the mental picture of the attachments of muscles and the estimation of their strength, the angle at which they pull, and the amount of displacing effect they have on the fracture as it exists. The second step should be a thorough consideration of the equipment necessary for reduction of the fracture, and the equipment necessary to hold it in reduction. This is fully as essential as having all operative equipment at hand and ready for immediate use before attempting any open operation.

The theory of reduction and proper retention of fractures is based on one principle—traction balanced by countertraction. The fragments must be held in alinement by counterbalancing the displacing effect of the muscles attached to them. In most cases this is simple. Open operation is unnecessary in the vast majority of fractures, in my opinion, if the anatomy is understood, the physiology of the structures is taken into consideration, and the details of the mechanics of reduction and retention are carefully thought out.

Many times traction for maintaining reduction is carelessly applied. Usually the best method of maintaining traction is by the application of adhesive plaster to the skin. It should not be applied as longitudinal bands, but as three-tailed strips (Fig. 1); the wide center bands run directly up each side of the limb, and the narrow side strips are wound corkscrew fashion around the limb (the anterior strips being crossed and wrapped around from front to back and the posterior strips from back to front). This eliminates straight downward pull on the skin, grips the limb circularly, does away with much skin irritation and allows greater weight to be applied with less discomfort. Almost any fracture can be pulled into line if skin traction is applied in this way with due consideration for the parts involved.

The manual reduction of fractures is ill advised as a general rule, because the strength of the muscles attached around the fracture is greater than the force which the operator can apply by manual manipulation. The operator's muscles tire and pass from tonic contraction into clonic contraction. Jerky motion will irritate the tissues about the fracture and cause reflex spasm in the muscles, which further interferes with proper reduction. Any effort at reduction should be steady, strong, and prolonged to the point where the patient's muscles are tired out and relaxed sufficiently to permit the fragments to be brought into alinement, and this can be accomplished only by mechanical means which relieves the surgeon of strain and frees his hands to manipulate the fragments until the ends can be approximated and forced into contact. Therefore, in every fracture, provision should be made for applying slow, steady, and prolonged traction.

In fracture of the arm, when the line of fracture is transverse or nearly so, immediate reduction may be made by means of a heavy muslin bandage looped around the patient's wrist or elbow and passed over the surgeon's shoulder (Fig. 2). The patient is secured to the table by a bandage placed around the chest under the axilla, thus fixing him firmly on the table and permitting the kind of traction necessary. Traction always calls for countertraction, and this countertraction should be arranged for before traction is started. With the bandage loop around his shoulder the surgeon may press his foot against the cross bar between the legs of the table and use his weight against the bandage to apply traction. He is under no strain, both hands are free, there is no interference with his sense of touch, and the pull can be continued until the patient's muscles are thoroughly relaxed, when the reduction can be accomplished with ease.

Strong traction may be applied in fracture of the leg by a Collins' hitch (Fig. 3) placed around the ankle and a double pulley fastened under the sole of the foot by tying the ends of the hitch through the eye of the pulley. Another double pulley is attached to the foot of the table, and the

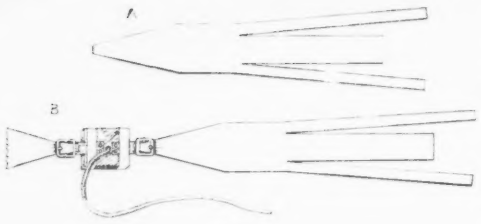


Fig. 1.

two are joined by a piece of clothesline. Here, too, countertraction must be provided, the simplest method being to pass a sheet between the patient's thighs and tie it to the head of the table. Tremendous traction may thus be applied without any marked exertion on the part of the surgeon, who is free to manipulate the fragments while an assistant increases the traction as directed.

All is not finished, however, when the fracture is reduced. The application of a cast or splint while maintaining the fracture in position is no mean feat, and must be carefully planned before reduction is started. Many fractures have been displaced after proper reduction because of improper handling by an assistant while the surgeon was engaged in applying the apparatus. No man can hold a weight in his hands for 15 minutes, or 10 minutes, or even 5 minutes, in exactly the same position, and the danger of inadvertent movement is increased by the number of hands supporting the injured member. Fractures must be reduced mechanically and must be maintained mechani-

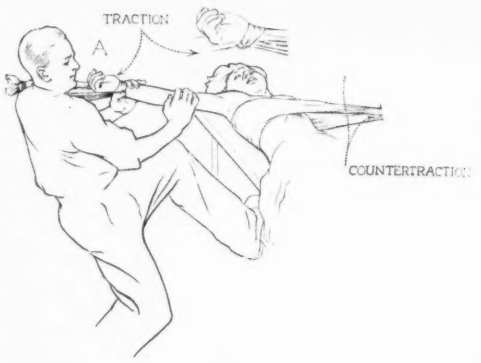


Fig. 2.

cally, and the mechanics of applying the retention apparatus must be arranged beforehand, or the case may come to grief. It is a difficult matter to apply a cast or splint without an assistant, and in many cases the assistant at hand is not skilful, is frequently nervous, and cannot be depended upon to do exactly the right thing at the right time.

In a fracture of either the leg or arm it is sometimes necessary to maintain traction while the

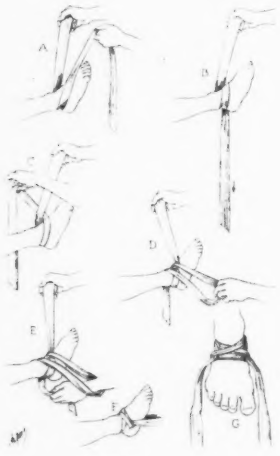


Fig. 3.

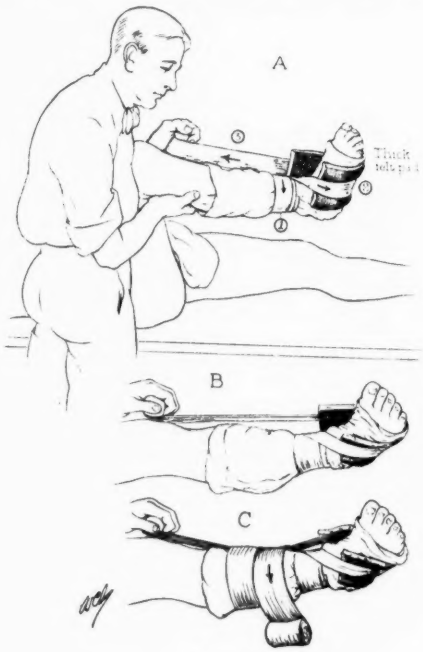


Fig. 4.

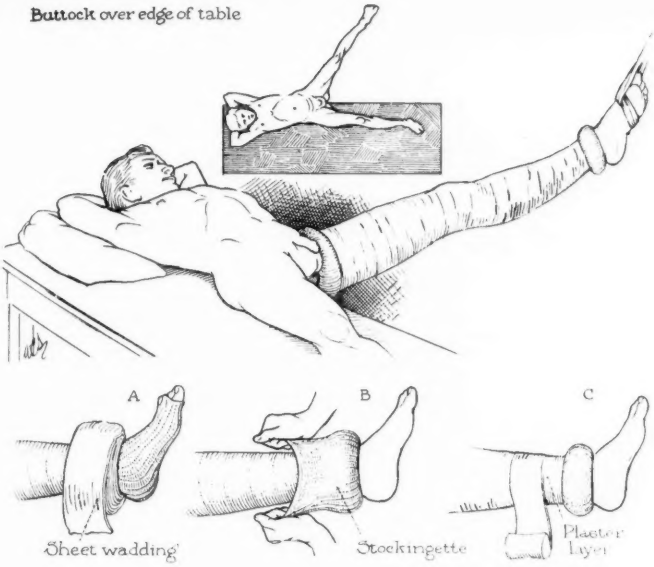


Fig. 5.

Fig. 6.

cast is being applied. If the limb is in a horizontal position, steady support should be given above and below the fracture as well as at the point of fracture in order to prevent angulation. For the leg, a wide muslin sling supported from a horizontal bar above can be applied in such manner as to eliminate the possibility of angulation after the fracture is reduced, and permit maintenance of traction in any given line and in any given amount. This sling is made with a piece of muslin equal in width to the length of the member to be supported. It is torn in 4 inch strips from each end to within 4 to 6 inches of the middle, leaving the center section intact, thus forming a sling, the narrow strips of which, tied to a horizontal bar above the limb, can be adjusted at any desired point to form a smooth and firm support over the entire length. Traction can be continued by a Collins' hitch below and above, by the use of either pulleys or weights. The cast is applied over this muslin support, the bandage being passed between the strips and made continuous over the entire posterior surface of the leg. When the plaster is firm enough to preclude the possibility of bending, each alternate strip may be cut loose from its overhead support and the application of plaster continued. When the cast is completely hardened, the remaining strips may be cut from the overhead support and the windows in the cast which remain as a result of surrounding the strips with plaster can be covered.

In the application of plaster where the limb can be fixed perpendicularly, as in the forearm, traction can be made by passing loops around the fingers and attaching these loops to an overhead support. If the weight of the arm does not afford sufficient countertraction a sandbag thrown over the lower end of the humerus just above the elbow will give all the countertraction necessary to maintain the fragments in position.

In maintaining inversion in fractures above the ankle, particularly in Pott's fracture and fracture of the os calcis, it is frequently difficult to rotate the foot inward and maintain this inversion without denting the cast at some point, as inversion must be maintained by pressure of the assistant's or the operator's hands. Here it is advantageous to protect the foot with a heavy felt pad, with a few turns of plaster bandage around the ankle, bringing the plaster down from the ankle over the outside of the foot, under the sole, and up toward the knee on the inner side. An assistant grips the bandage roll in one hand, and while supporting the leg with the other hand, maintains the knee in right angle flexion supported against his chest (Fig. 4). If the bandage is passed around the foot immediately under the astragalus the foot will be inverted at the subastragaloid joint, the location

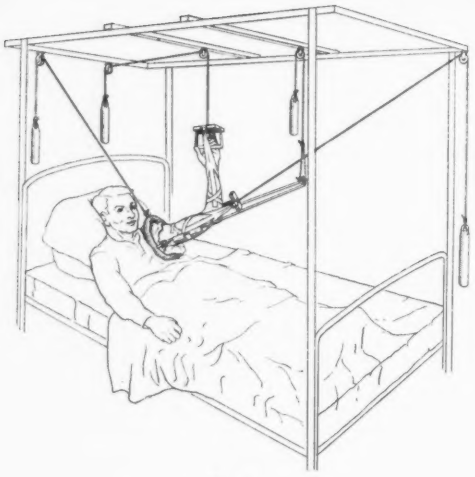


Fig. 7.

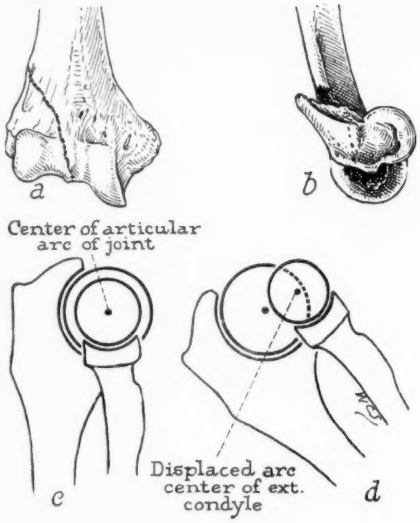


Fig. 8.

where inversion should take place. Inversion is easily maintained, and the operator's hands are free to apply the cast. Grasping the ball of the foot to turn the toes in merely inverts the anterior part of the foot, but does not invert the sub-astragular bones.

Casts applied for fractures or injuries in or near the knee joint frequently do not accomplish their purpose—namely, immobilization—because the cast is not applied so that it will give equal leverage on both sides of the fracture. The extension of the cast down onto the leg toward the foot can be carried out simply and easily, but the application of a long cast to the thigh is not so simple. The muscles around the thigh are heavy, and immobilization is impossible unless the cast is made very snug, and if the cast does not extend as far above the fracture as below the immobilizing effect is not good. Therefore, where it is desired to immobilize the knee or to support the femur after a fracture of this bone has healed, the patient should be drawn well over to the side of the table and the leg should be brought into full abduction (Fig. 5). The top of the cast may then be brought up into the gluteal fold and up against the ischium, thus giving as long a lever above the knee as below. If the upper and lower ends of the cast are well padded with sheet wadding and the stockinet is rolled back over the sheet wadding after the cast is applied, there is ample protection of the soft parts from pressure (Fig. 6). A walking caliper can be made by placing a U-shaped piece of iron under the foot, the uprights of the iron being included in the lower end of the cast on each side of the leg. The ischium will rest on the pad at the upper end of the cast and the weight will be transmitted to the iron.

In fracture of the surgical neck of the humerus when it is necessary to maintain traction to reduce the fracture, the apparatus used should center in its motion exactly under the glenoid fossa. Traction should be started with the arm in about 20 to 30 degrees of abduction and the elbow gradually be brought forward as the arm is abducted. If the arm is immediately abducted and put in traction, the upper end of the lower fragment is thrown downward and forward as the elbow is brought outward, because here the attachment of the pectoralis major acts as a fulcrum, and until this muscle is either relaxed or stretched the lower fragment cannot be brought down into position (Fig. 7).

Fractures of the lower end of the humerus into the elbow joint probably give as unsatisfactory results as any class of fractures. This is due to several factors. In the first place, the bones of the forearm articulate with two almost completely separate joints on the end of the humerus, and when fracture into the elbow joint occurs these joints are separated. The muscles attached to the lower end of the humerus have a tendency to displace the fragments in different directions. The centers of the two condyles around which the radius and ulna rotate on the lower end of the humerus normally are exactly in the same axis, but when the condyles are fractured the alinement

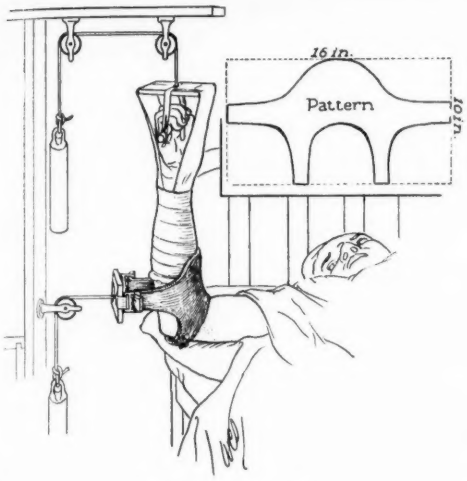


Fig. 9. (See Fig. 16).

of this axis is disarranged and is very difficult to re-establish, because the humerus just above the condyles is extremely thin in its anteroposterior diameter, while its lateral diameter is widened (Fig. 8). Open reduction of such fractures is not satisfactory as a rule because it entails considerable damage to the ligamentous attachments around the elbow. Furthermore, it is very difficult to fix the two condyles to the lower end of the humerus on exactly the same pivot, because the lower end of the upper fragment, which articulates with these two condyles, is so thin from front to back that it is next to impossible to drive a peg or nail from below upward and have any stability between the fragments. If they are wired, the wire does not hold them in firm enough position to maintain the true axis, and as they heal there is apparently a great tendency for excess callus to form, which further contributes to blocking of the joint. These fractures can be reduced and maintained in reduction much more satisfactorily by traction applied in a very simple way.

The treatment is based on the fact that the ligaments attached to the condyles of the humerus and the radius and ulna will pull the fragments back into their normal centers and alinement, if the muscles attached to the condyles are balanced and relaxed. Therefore the forearm is suspended at right angles to the humerus with just enough traction applied to hold the elbow clear of the bed, thereby permitting the pronators and supinators of the forearm to find the position in

Fig. 10.

rotation in which they balance each other. Beneath the muscle attachments are the ligaments and the capsule, attached to the fragments. If traction is applied to the forearm with the elbow flexed, the lateral ligaments and the posterior ligaments are pulled tight. If continuous traction is made over the upper end of the forearm near the elbow with the elbow flexed, the anterior capsule is stretched tight as well as the lateral and posterior ligaments, and this pulls all the fragments of the lower end of the humerus into fairly normal relation with the radius and ulna, and re-establishes the relation of the axis of both condyles.

The procedure is simple and is easily carried out by cutting felt in a pattern which will fit closely around the elbow on its flexor surface. With traction applied to the felt close to the elbow joint, immediate traction can be transmitted to the fragments through the ligaments and muscles of the forearm at the elbow (Figs. 9 and 16).

Fractures of the olecranon always require open operation if the fragments are separated and the ligaments torn, which is usually the case. These fractures can be fixed in such a way that immobilization is unnecessary. The usual custom is to drill through the upper end of the lower fragment and through the middle of the upper fragment, passing kangaroo tendon, silk, or wire through the two holes to fasten the fragments together. Cancellous bone does not stand as much pull without atrophy as do the heavy attachments of the muscles. The triceps tendon is attached to the olecranon, and if malleable iron wire is used (which is the strongest form of wire with which we are familiar), the wire can be passed through the triceps tendon, posterior to the long axis of the olecranon and ulna, and fastened to the lower fragment which is composed of hard cortical bone (Fig. 10). If the fragments are held together in

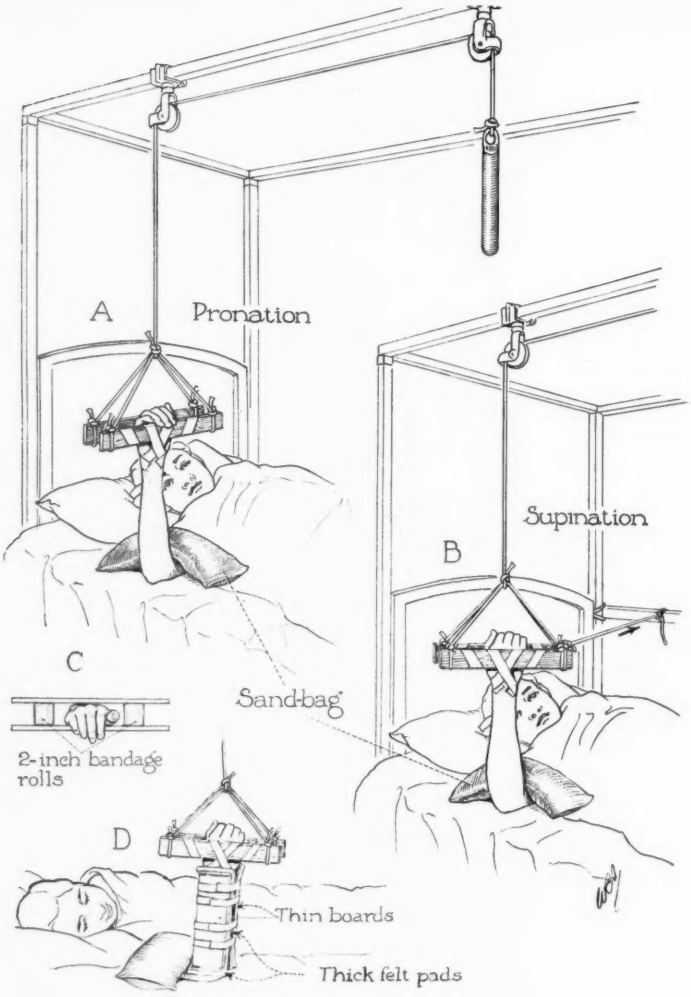


Fig. 11.

this way the pull of the triceps muscle is transmitted through the wire directly to the lower fragment, and any angulation at the posterior end of the fracture line is prevented. If the wire is put in line with the axis or anterior to the line of the axis, the triceps tendon has a tendency to separate the fragments at their posterior junction, and if they heal in this position extension is limited because the olecranon is pulled upward and into the olecranon fossa.

Motion can be started within 24 hours after operation in these cases, and union should be complete in from 4 to 6 weeks without disability in the elbow.

Fractures of the forearm, which are probably more difficult to reduce than any other fractures in the body, in many instances should not be treated as ambulatory cases. When there is serious displacement, reduction by manual manipulation is usually impossible. The fascia surrounding the muscles of the forearm is strong, the muscles are extremely active and tend to con-

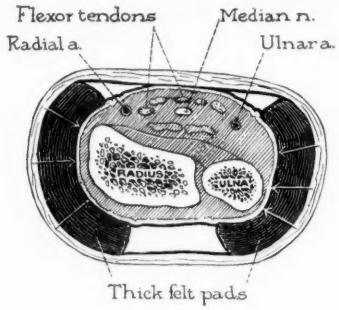


Fig. 12.

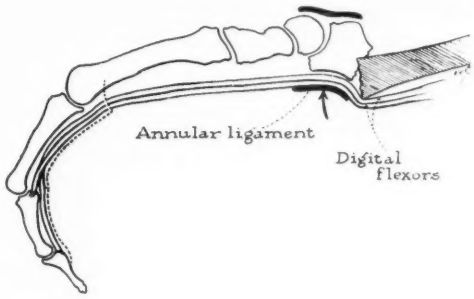


Fig. 13.

tract and maintain the fragments in malposition. There are no fractures which need steady, continuous, tiring traction more than do fractures of the forearm. Serious disability results if union is permitted with angulation or abnormal rotation between the radius and ulna. Disability of the forearm means disability of the hand, because the dexterity of the hand is dependent to a great extent upon the integrity of the bones of the forearm.

In order to maintain traction on the forearm it is necessary to apply some form of countertraction, inasmuch as the weight of the upper arm is not sufficient to overcome the pull of the muscles. Therefore, the forearm should be placed in suspension. An adhesive plaster cuff is placed around the wrist, attached to horizontal strips of wood at the level of the metacarpophalangeal junction. Countertraction may be applied by placing a sandbag of the requisite weight across the lower end of the humerus just above the elbow. Rotation of the radius may be controlled by attaching to the horizontal crossbars a rope which controls this motion. When sufficient traction has been attained to bring the fragments into alinement they may be supported by double board splints on the flexor and extensor surfaces (Fig. 11).

In fracture of the radius without fracture of the ulna, there is, in addition to the deformity, a disarrangement of the radio-ulnar joint at the wrist. As the radius shortens, the relation of the radius and ulna at the wrist joint is changed, the hand is pulled into radial flexion, and the ligaments which support the radio-ulnar joint are either torn or stretched. In every fracture of the radius without fracture of the ulna, normal length of the radius, with normal relation of the fragments so far as rotation is concerned, must be re-established in order to re-establish complete function in the hand and wrist. Even with restoration of normal length in the radius, there is sometimes severe injury to the ligaments holding the two bones together, which will result in serious disability if not given special support. Relaxation of this joint may occur which will leave a serious disability so far as the strength and the dexterity of the hand are concerned. After such injury, therefore, whether it be fracture in the shaft of the radius or Colles' fracture, this joint must be supported, and this can best be done by placing a thick felt pad laterally over the radius and over the ulna, allowing each of them to fold around the flexor and extensor surfaces. The two pads are then forced toward each other by including them in a tightly strapped circular band of adhesive plaster. It is impossible to put a circular band snugly around the wrist unless the flexor and extensor surfaces are protected from pressure, because it would interfere with circulation and cause swelling and congestion in the hand, but with thick pads applied laterally this is prevented, as the adhesive plaster does not touch the flexor and extensor surfaces (Fig. 12).

Probably the most common fracture with which we have to deal is Colles'. In this fracture there is a backward and upward displacement of the lower fragment, and the fragments are usually rather firmly impacted. When the lower fragment moves backward and upward it carries backward with it the annular ligament. The lower articular surface of the radius is carried backward and upward, and, in a typical deformity, instead of the lower end of the radius facing toward the flexor surface, it faces toward the extensor surface. This deformity also produces a double bend in the flexor tendons, forcing them under the lower end of the upper fragment where they are kinked rather sharply backward to pass toward the fingers under the annular ligament, which has been carried backward. This double bend, in tendons which should run straight from the muscles from which they originate to the bones to which they

Fig. 14.

Fig. 15.

are attached, diminishes the strength of the pull of the muscles (Fig. 13). In addition, the hand is carried into radial flexion by the shortening of the radius, and the radio-ulnar joint is disarranged. Unless this deformity is corrected, unless the lower fragment is brought into correct apposition with the upper fragment, the double bend in the tendons removed, and the lower articular surface of the radius brought into proper angle with the long axis of the radius (namely, facing slightly toward the flexor surface), three serious disabilities occur. First, limitation of supination, because of the disarrangement of the radio-ulnar joint; second, limitation of flexion of the wrist, because of the change in the angle at which the lower fragment articulates with the upper; and third, diminution in the strength of the hand because of the displacement of the lower fragment, plus the double bend in the flexor tendons at the wrist and possible adhesions.

Reduction is easily carried out, and the earlier the better. Traction should be applied over the base of the hand by a bandage loop extending from the hand over the operator's shoulder. First the impaction should be broken up. With the thumbs over the ends of the fragments on the extensor surface of the lower end of the radius, the deformity should be increased until the fracture is perfectly loose and the fragments move freely on each other (Fig. 14). Until complete breaking up of the impaction is brought about traction is useless, but when it is accomplished longitudinal traction on the arm will bring the lower fragment down to a point where its fractured surface is at a level with the fractured surface of the upper fragment. Pressure forward with the thumbs on the lower fragment, and backward with the fingers on the lower end of the upper fragment, will then force the fragments into alinement and bring the articular surface into its normal position (Fig. 15).

In elderly patients it is sometimes impossible to re-establish the normal length of the radius, because in the impaction there has been an actual disintegration of cancellous bone cells, resulting in a loss of bone substance which permanently shortens the radius. In these cases some deformity will remain.

No one method can be made to apply to all cases, even those of the same type. Variations must be made according to the needs of the case. When dealing with fractures one is dealing with a problem in mechanics. A fundamental knowledge of the anatomy and physiology is as important in dealing with the stress and strain on the fractured fragments as is the knowledge of physics to an engineer in undertaking a problem of purely mechanical construction. The main difference is that the surgeon must take into consideration the fact that power and breaking force are applied to a fracture during 24 hours of the day, because the muscles continue to contract until they encounter resistance which will counterbalance the strength of their pull. The surgeon also has the additional problem of not being able to exert enough mechanical force directly on the part to be treated to bring it into alinement and maintain it in alinement without the hazard of injuring living tissue.

Fig. 16. Anterior and lateral views of comminuted fracture of lower end of the humerus into the elbow joint. The same 24 hours later, after the application of extension.

Therefore, ingenuity and ability to meet individual requirements are much more important in dealing with a fracture than in the average engineering problem.

In the methods given herewith only such mechanical apparatus has been described as can be improvised from materials to be found around almost any farmhouse. These methods are not advocated as the only means of handling such problems, but are advanced to point out the fundamental principles of treatment of certain fractures, and they can be varied by the ingenuity of the surgeon to meet the requirements of any given case. As stated in the beginning of this article, there are certain fractures which cannot be reduced and maintained in reduction satisfactorily without open operation, but the differentiation should be made early in the case and not be postponed until faulty union or nonunion has resulted.

THE RUSSELL EXTENSION METHOD IN THE TREATMENT OF FRACTURES OF THE FEMUR

A Review of the Anatomical Results Obtained in a Group of Fifty-One Cases

WALTER ESTELL LEE, M.D., Philadelphia, J. ROSS VEAL, M.D., New Orleans, Louisiana

In 1923 R. Hamilton Russell, of Melbourne, Australia, first published his report of a method to obtain reduction of the fragments in fractures of the femur. "This employs a natural and comfortable position of the extremity, in which but a relatively small amount of traction is required to restore the balance or equilibrium of the muscles of the thigh when it is applied distally to the knee joint."

In 1927, Ryan of Philadelphia called attention to this method, reporting 8 cases; in 1929, Ridgely and Bongardt 15 cases; in 1930, Jopson and Brown 42 cases; and in 1931, Lund published his end-results in 22 cases.

At the Philadelphia meeting of the Clinical Congress of the American College of Surgeons in 1931, Summey demonstrated the end-results of a group of 58 cases of fractures of the femur treated by Russell's extension in which there was but one case of non-union, caused by the interposition of muscle and requiring open reduction. This work has never been published.

Following this report of Summey, we decided to use this method in the surgical services of the Graduate Hospital of the University of Pennsylvania, the Pennsylvania, Bryn Mawr, Germantown, and Burlington County Hospitals.

The impression made on Scudder by our first report, together with his knowledge that we were using this type of extension almost routinely in our five hospitals, may be responsible for his invitation again to review our results.

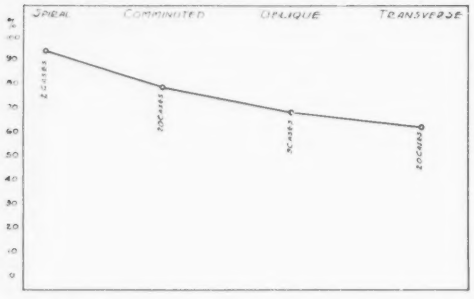


Fig. 1. Effect of the type of fracture on anatomical reduction.

The fact that 10 years after the publication of Russell's article we have been able to find in the literature records of but 87 cases treated by this method containing the data required for a critical analysis has been a surprise.

These reports are uniformly favorable and Lund expresses the opinion of the others in saying "I have been impressed with the ease of application of this method and by the comfort it affords the patient. It facilitates the dressing of compound wounds and makes easy daily inspection and measurement. Early massage and other physical therapeutic measures may be given together with excellent care of the soft structures and adjacent joints. The end-results have been excellent, and a minimum of residual disabilities of the joints have occurred compared to those following other methods." In but one of these reports is there any warning of its limitations, and this is found in the original article of Russell. "The apparatus is far from fool-proof and cannot and will not look after itself."

Two definite impressions developed very early in this study and became more fixed as the work progressed: (1) That the results obtained in these five hospitals were far from uniform. In fact, they varied so much that it was a matter of general comment. (2) That the average of the anatomical results was not as satisfactory as we had believed it to be.

Fig. 1A. No. 1. Robson, age 5, Burlington County Hospital. Spiral comminuted fracture, upper third of femur. Picture taken before application of extension.

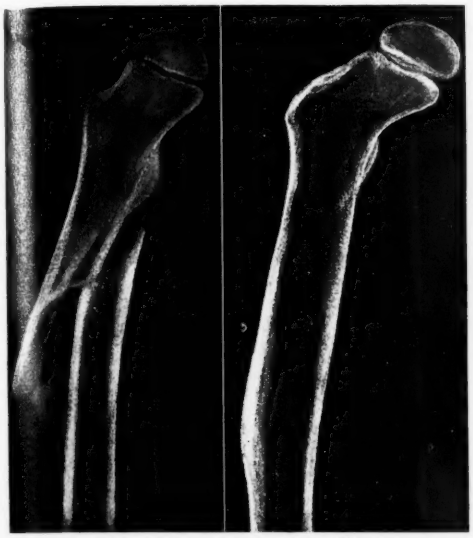
Fig. 1B. No. 2. Robson, Burlington County Hospital. Age 5. Picture taken at time of discharge from Hospital. Alinement 50 per cent, overlapping 25 per cent, end-to-end apposition 12.5 per cent, total 87.5 per cent.

Fig. 1C. No. 1. K. Johnson, Bryn Mawr Hospital. Comminuted intertrochanteric fracture. Picture taken before reduction.

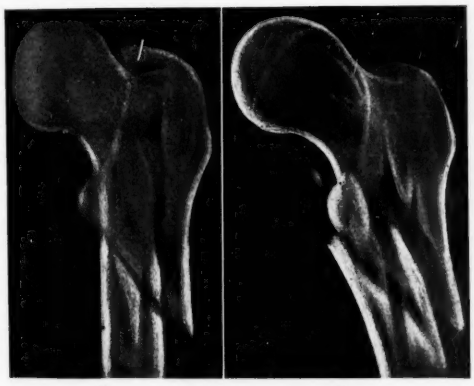
Fig. 1D. No. 2. K. Johnson, Bryn Mawr Hospital. Comminuted intertrochanteric fracture, taken at time of discharge. Alinement 50 per cent, overlapping 25 per cent, end-to-end apposition 22.5 per cent, total 97.5 per cent.

Fig. 1E. No. 1. J. Johnson, 33 years of age, Graduate Hospital. Oblique fracture middle third of femur. Picture taken before reduction.

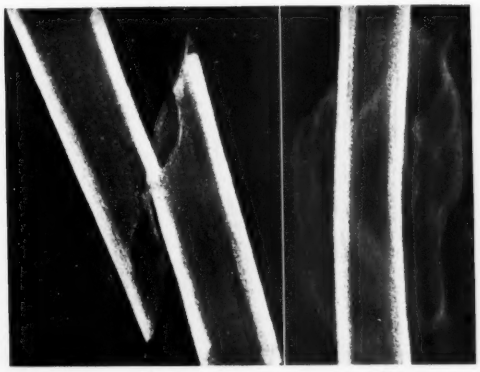
Fig. 1F. No. 2. J. Johnson, 33 years of age, Graduate Hospital. Picture taken at time of discharge from hospital. Alinement 50 per cent, overlapping 25 per cent, end-to-end apposition 17.5 per cent, total 92.5 per cent.



A. B.



C. D.



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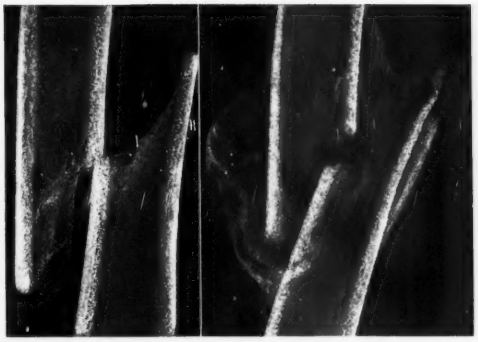
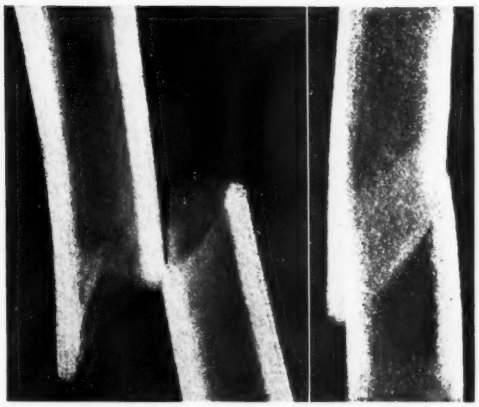


G. H.



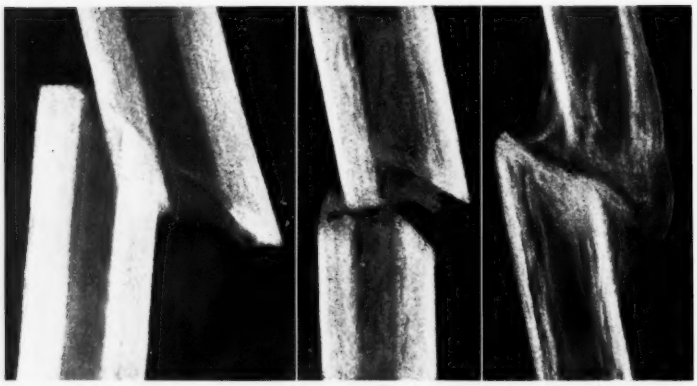
I. J.

Fig. 1G. No. 1. Mignon, Burlington County Hospital, age 76 years. Oblique fracture middle third of femur. Picture taken before application of extension.

Fig. 1H. No. 2. Mignon, Burlington County Hospital, age 76 years. Picture taken at time of discharge. Alinement 45 per cent, overlapping minus 25 per cent, end-to-end apposition 5 per cent, total 50 per cent.

Fig. 1I. No. 1. Howard, Burlington County Hospital, age 12 years. Transverse fracture middle third of femur. Picture taken before application of extension.

Fig. 1J. No. 2. Howard, Burlington County Hospital, age 12 years. Picture taken at time of discharge from hospital. Alinement 50 per cent, overlapping 25 per cent, end-to-end apposition 15 per cent, total 90 per cent.

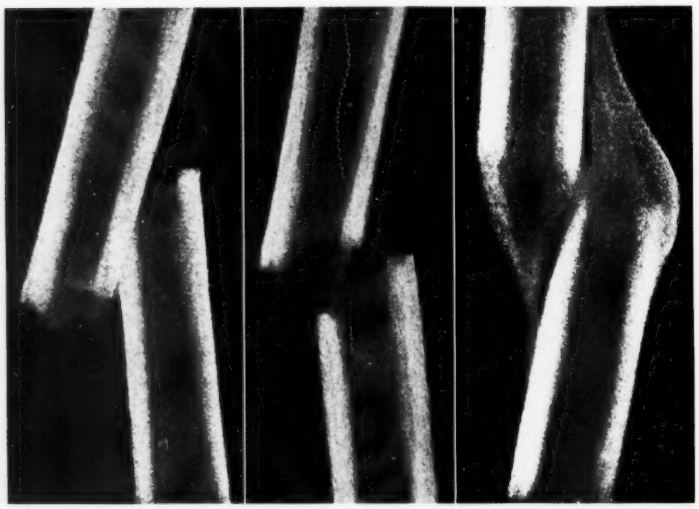


K. L. M.

Fig. 1K. No. 1. Minton, Pennsylvania Hospital, 63 years of age. Transverse fracture middle third of femur. Picture taken before application of extension.

Fig. 1L. No. 2. Minton, Pennsylvania Hospital, 63 years of age. Picture showing reduction following the application of Russell extension.

Fig. 1M. No. 3. Minton, Pennsylvania Hospital, 63 years of age. Picture taken at time of discharge from hospital, showing failure to maintain the reduction which was at first obtained. Alinement 50 per cent, overlapping 5 per cent, end-to-end apposition 12.5 per cent, total 67.5 per cent.

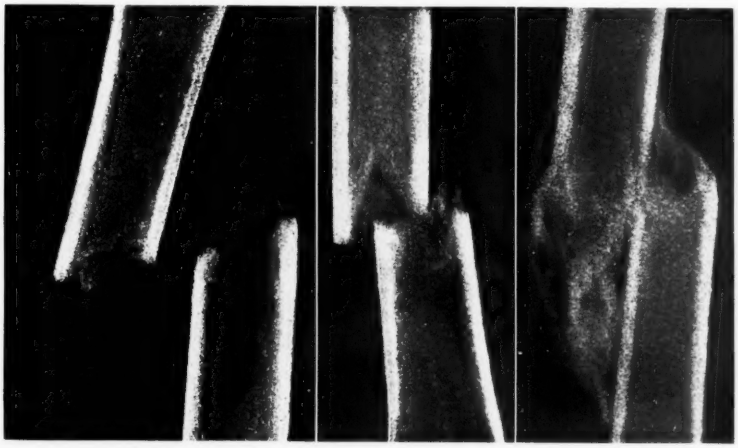


N. O. P.

Fig. 1N. No. 1. Campbell, Burlington County Hospital, 12 years. Transverse fracture middle third of femur. Picture taken before application of extension.

Fig. 1O. No. 2. Campbell, Burlington County Hospital, age 12 years. Picture taken after application of extension, showing partial reduction.

Fig. 1P. No. 3. Campbell, Burlington County Hospital, age 12 years. Picture taken at time of discharge from hospital, showing failure to maintain reduction which was obtained following the application of extension. Alinement 42.5 per cent, overlapping 25 per cent, end-to-end apposition 10 per cent, total 77.5 per cent.

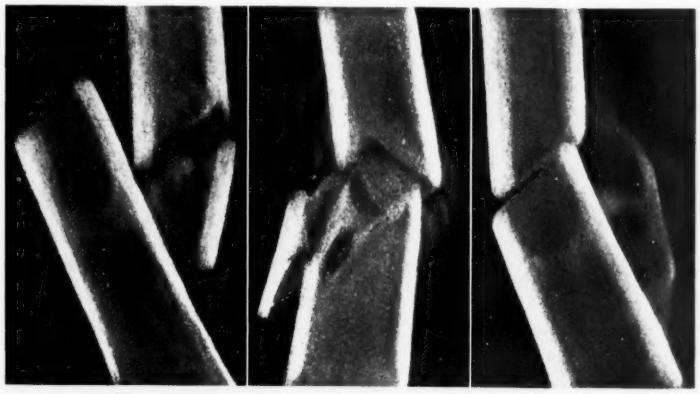


Q. R. S.

Fig. 1Q. No. 1. Festas, Pennsylvania Hospital, age 10 years. Transverse fracture middle third of femur. Picture taken before application of extension.

Fig. 1R. No. 2. Festas, Pennsylvania Hospital, age 10 years. Picture taken after application of extension, showing partial reduction.

Fig. 1S. No. 3. Festas, Pennsylvania Hospital, age 10 years. Picture taken at time of discharge from hospital, showing failure to maintain the reduction obtained following extension. Alinement 50 per cent, overlapping minus 25 per cent, contact minus 25 per cent. Rating 50 per cent.



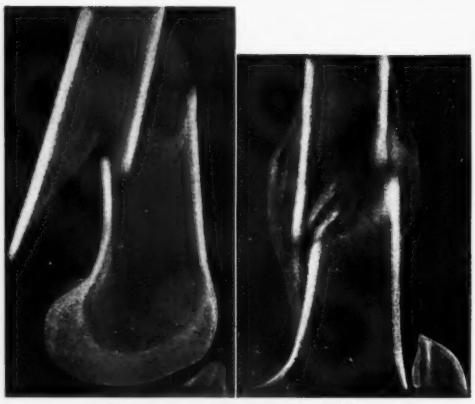
T. U. V.

Fig. 1T. No.1. Feldman, Graduate Hospital, age 30. Comminuted transverse fracture lower third of femur. Picture taken before application of extension.

Fig. 1U. No. 2. Feldman, Graduate Hospital, age 30. Picture taken at time of discharge. Anteroposterior view.

Fig. 1V. No. 3. Feldman, Graduate Hospital, age 30. Picture taken at time of discharge from hospital. Lateral view, showing posterior angulation at site of fracture. Alinement 43 per cent, overlapping 25 per cent, end-to-end apposition 24 per cent, total 92 per cent.

We have been forced, therefore, to admit that the impression one receives from the literature that it is so simple of application and so easy to maintain, that it is almost fool-proof, has not been borne out by our experience. That it is possible to obtain the excellent results exhibited by



W. X.

Fig. 1W. No. 1. Coughney, Pennsylvania Hospital, 49 years of age. Supracondylar fracture lower end of femur. Picture taken before application of extension. Note the lower fragment is anterior.

Fig. 1X. No. 2. Coughney, Pennsylvania Hospital, 49 years of age. Picture taken at time of discharge from hospital. Alinement 50 per cent, overlapping 25 per cent, end-to-end apposition 22 per cent, total 97 per cent.

Y. Z.

Fig. 1Y. No. 1. Balcumas, Pennsylvania Hospital, 44 years of age. Picture taken before application of extension. Lower fragment is posterior.

Fig. 1Z. No. 2. Balcumas, Pennsylvania Hospital, 44 years of age. Supracondylar fracture lower end of femur. Alinement 41 per cent, overlapping 25 per cent, end-to-end apposition 10.8 per cent, total 52.25 per cent.

other surgeons has been demonstrated by us in this group of cases, but our results have not been uniform, and if this report is to have any value it will consist not only in the exhibition of our failures, but also in the presentation of explanations of these failures. That we have been able to obtain the results reported by others is shown by the fact that 16 of these 51 cases have received a rating of from 90 to 100 per cent of anatomical restoration. Of these cases 7 were from Hospital A, in which we consistently found the best results, but there were also 3 cases from Hospital B, 4 from Hospital C, and 2 from Hospital D, but none from Hospital E.

In the limited time allowed for the making of this survey it has been impossible to study all of the factors contributing to our final results, and we confined our efforts to an estimation of the anatomical restoration at the time of the patient's discharge from the hospital, feeling that this offers the best index of the efficiency of any method of extension or traction.

In estimating the anatomical restoration of these fractures of the long bones we have arbitrarily given 50 per cent for alinement, 25 per cent for end-to-end apposition, and deducted 25 per cent for overlapping.

Using this rating we found that the average anatomical restoration in the five hospitals was 70.5 per cent. The variations in the results in the five hospitals is shown by the following tables (Fig. 2).

		Cases	Per cent
Hospital A	90–100 per cent	7	25.9
	80– 90 per cent	5	20.9
	70– 80 per cent	6	23.0
	60– 70 per cent	0	...
	50– 60 per cent	5	20.9
	Under 50 per cent	1	4.3
Hospital B	90–100 per cent	3	60
	80– 90 per cent	0	...
	70– 80 per cent	2	40
	60– 70 per cent	0	...
	50– 60 per cent	0	...
	Under 50 per cent	0	...
Hospital C	90–100 per cent	4	50
	80– 90 per cent	1	12.5
	70– 80 per cent	0	...
	60– 70 per cent	0	...
	50– 60 per cent	0	...
	Under 50 per cent	3	37.5
Hospital D	90–100 per cent	2	8.1
	80– 90 per cent	1	9.2
	70– 80 per cent	2	8.1
	60– 70 per cent	0	...
	50– 60 per cent	4	16.4
	Under 50 per cent	2	8.2
Hospital E	90–100 per cent	0	...
	80– 90 per cent	0	...
	70– 80 per cent	0	...
	60– 70 per cent	2	6.4
	50– 60 per cent	0	...
	Under 50 per cent	1	3.6

In an attempt to find more or less constant factors which would be operative in the five institutions and which would account for these variable results, we have analyzed (1) the age of

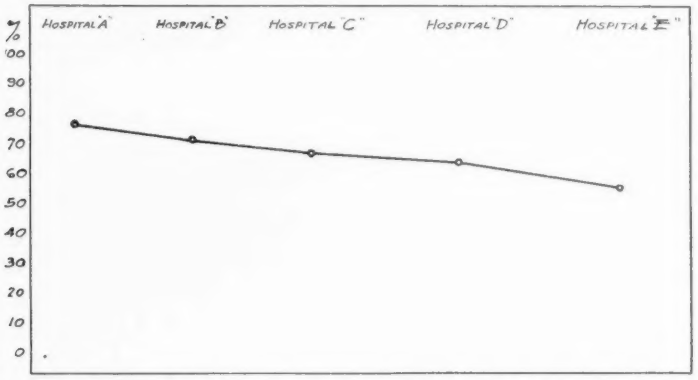


Fig. 2. Comparison of the anatomical reduction obtained by Russell's extension in five hospitals.

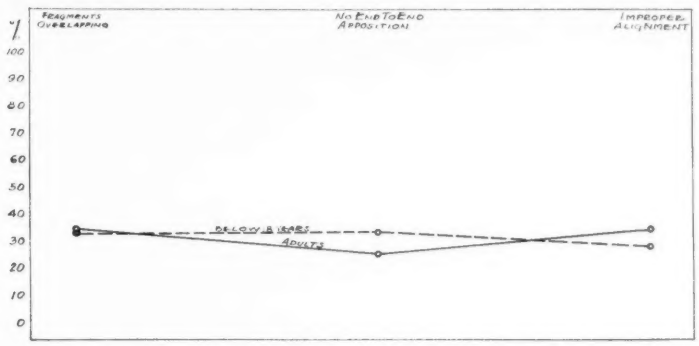


Fig. 3. Comparison of the results in growing and adult bones.

the patients, dividing them into two groups, under 18 and over 18, with the classification of adult and growing bones; (2) the character of fracture, spiral, oblique, transverse or comminuted; (3) the location of fracture, intertrochanteric and subtrochanteric, upper third of the femur, middle third of the femur, lower third of the femur and supracondylar; (4) the interval of time between the receipt of the injury and the application of the extension, using 12 hours as the minimum; (5) an estimation of the efficiency of application of the extension according to the principles outlined by Russell, or of failure to maintain these principles subsequent to its application; and (6) the premature removal of the apparatus.

It seemed reasonable to divide these factors into two groups: first, those over which the surgeon had no control, and second, those over which he should have had complete control.

The factors over which the surgeon had no control and which in our statistics appear to have definitely influenced the results are: (1) the age of the patient; (2) the type of the fracture; and (3) the location of the fracture.

The factors over which the surgeon should have had complete control were (1) the time elapsing between the receipt of the injury and the application of extension; (2) the efficiency of the application of the apparatus and the success or failure to maintain the principles of Russell subsequent to its application; and (3) the premature removal of the apparatus before solidification of the callus.

UNCONTROLLABLE FACTORS

Age. Contrary to our expectations, there was practically no difference in the anatomical reduction obtained in the growing (69.5 per cent) and in the adult (70.2 per cent) bones. We wish to make clear that this does not refer to the end-results or the functional results, but to the anatomical restoration that existed at the time of the

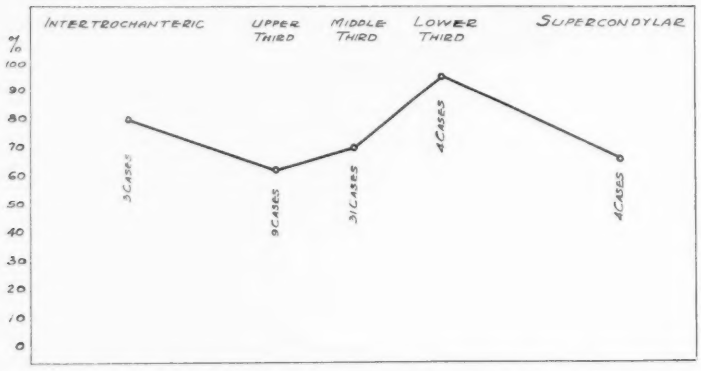


Fig. 4. Effect of location of fracture on anatomical reduction by Russell's extension.

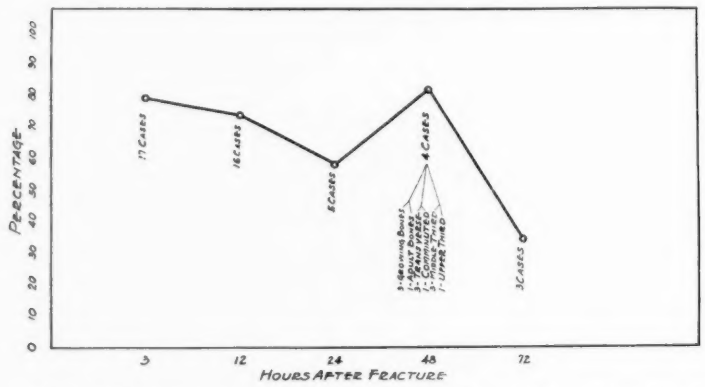


Fig. 5. Effect of time of application of Russell's extension on failure to obtain anatomical reduction.

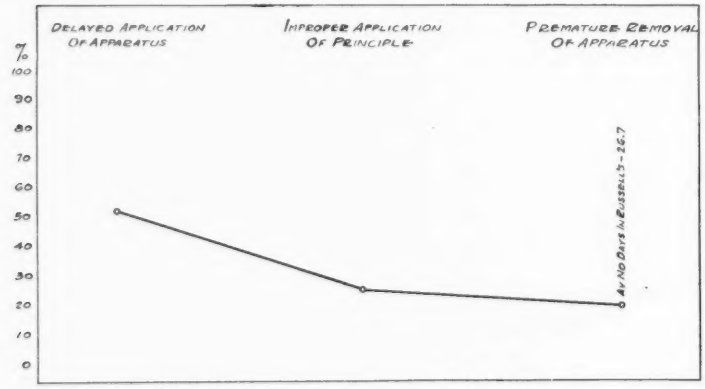


Fig. 6. Causes of failure to overcome overlapping.

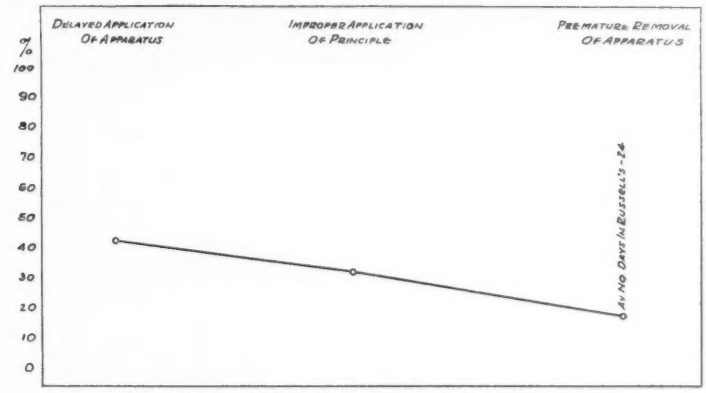


Fig. 7. Causes of failure in obtaining end-to-end apposition.

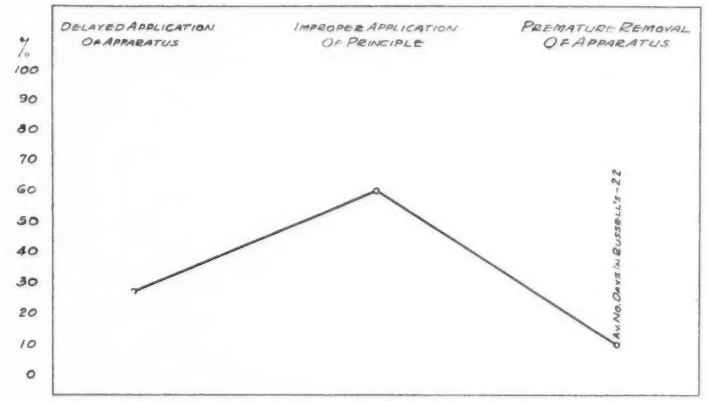


Fig. 8. Causes of failure to obtain proper alinement.

discharge from the hospital. The repeated statements of Ashhurst, Speed, and others, that shortening as a rule may be disregarded in early childhood, and of Pfeiffer that he never saw a fracture in the shaft of the femur of a child that did not give a good result, applies to the final results in all of these fractures in growing bones (Fig. 3).

There is a wide range in the ages of the patients included in this study. The youngest was 4 years of age. His fracture was of the transverse type and was located in the middle third. There was an overlapping of 2 centimeters. Excellent reduction was obtained. The oldest patient was 79 years of age. Her fracture was also transverse, in the middle third, and had 4 centimeters overlapping. Excellent reduction was obtained.

In the growing bone group, i.e., patients below the age of 18 years, there were 20 fractures. Six of these were under 10 years of age. There were 12 between the ages of 10 and 15 years. Two cases were 16 years of age. Five of the fractures were in the upper third, and 15 in the middle third. Eleven were transverse, 4 were comminuted, 3 were oblique, and 2 were spiral.

The average time of Russell extension in this growing group was 35.4 days. The average stay in the hospital was 49 days. The final average percentage of anatomical reduction was 69.5.

In the adult group there were 31 fractures. Three were intertrochanteric, 4 in the upper third, 16 in the middle, 4 in the lower third, and 4 were supracondylar. According to the type of fracture, we find 16 were comminuted, 9 were transverse and 6 were oblique. The average time in Russell extension for this group was 37.2 days; the average stay in the hospital, 66.1 days; the final average percentage of anatomical reduction, 70.2.

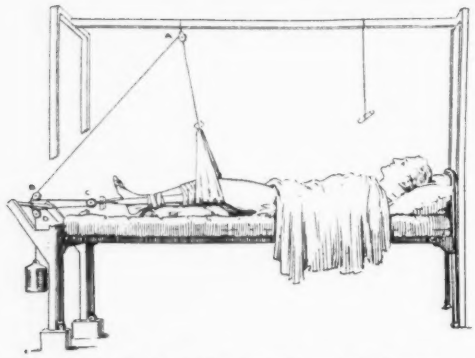


Fig. 9. The R. Hamilton Russell method of extension. (From Brit. J. Surg., 1924—11.)

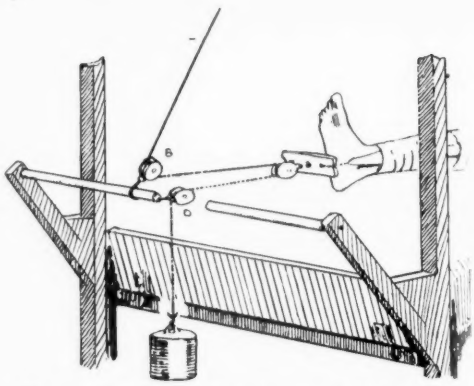


Fig. 10. Details of pulley arrangement at foot of bed. (From Brit. J. Surg., 1924—11.)

Type of Fracture. The best rating obtained was in the spiral fractures, next the comminuted, then the oblique, and the lowest rating was in the transverse fracture (Fig. 1).

Spiral fracture, average rating 95 per cent of anatomical reduction.

Comminuted fracture, average rating 79.5 per cent of anatomical reduction.

Oblique fracture, average rating 69.1 per cent of anatomical reduction.

Transverse fracture, average rating 63.4 per cent of anatomical reduction.

In analyzing the types of fractures in this series we find 2 were spiral, 20 were comminuted, 9 were oblique and 20 transverse. The two spiral fractures (Fig. 1A and B) were in growing bones and excellent reduction was obtained, 95 per cent. The average percentage of reduction for the comminuted group (Fig. 1D and 3U) was 79 per cent, for the oblique (Fig. 1E), 69.19 per cent, and for the transverse 63.48 per cent (Fig. 1I).

Location of the Fracture. In this group of 51 fractures (Fig. 4), 3 were intertrochanteric, 9 were in the upper third, 3 in the middle third, and 4 were supracondylar. The best results were obtained in fractures of the lower third of the femur, 96 per cent; in the intertrochanteric fractures, 80.3 per cent (Fig. 1C and D); the middle third of the femur, 70.97 per cent (Fig. 1Q and R); and in the supracondylar fractures, 63.41 per cent (Fig. 1W, X, Y, Z). The lowest rating was obtained in fractures of the upper third of the bone. Note the wide difference in results obtained in fractures of the upper and lower thirds. The short upper fragment in fractures of the upper third often caused anterior angulation. Excellent results were obtained in the intertrochanteric and lower third types. In one of the supracondylar fractures the distal fragment was anterior and perfect reduction resulted. In the others, however, the distal fragments were posterior and unsatisfactory results were obtained.

CONTROLLABLE FACTORS

In analyzing the controllable causes of failure to obtain and maintain reduction we find three main factors were operative. The first of these was delayed application of the apparatus. By this we mean that extension was applied later than 12 hours after the fracture occurred. The second factor was improper application of the principles of Russell's extension. Here the apparatus was not applied properly or it was not maintained properly throughout the healing stage. The third factor was premature removal of the extension. By this we mean that the extension was removed before adequate callus had formed to maintain reduction. Premature removal often resulted in overlapping or angulation.

DEFORMITIES

As noted above, we have allotted 50 per cent to proper alinement of the fragments, 25 per cent to full end-to-end apposition, and have deducted 25 per cent for overlapping.

In 19 fractures healing took place with some overlapping of the fragments (Fig. 6). The greatest amount of overlapping was 4 centimeters, the average being 2 centimeters. Seven, or 35 per cent, of these cases were in growing bones and 12, or 36 per cent, in adult bones.

In studying the causes of failure to overcome overlapping we find that in 52.63 per cent of the fractures it was due to delayed application of the apparatus; improper application and maintenance

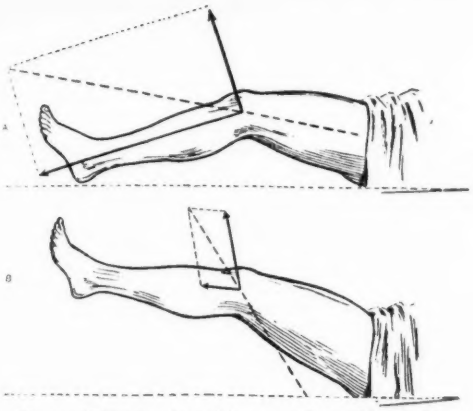


Fig. 11. The direction of forces. (From Brit. J. Surg., 1924—11.)

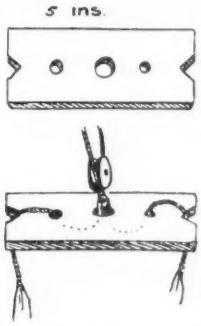


Fig. 12. The spreader used in Russell's apparatus. (From Brit. J. Surg., 1924—11.)

of the principles of Russell was responsible in 26.3 per cent, and premature removal of the apparatus in 21.05 per cent. The average days in Russell's extension was 26.7. The results noted above show clearly the importance of early extension.

In 16 of the total of 51 fractures there was either failure to obtain end-to-end apposition (Fig. 7) or to maintain it after the fracture was reduced. Seven, or 35 per cent, were in growing bones, and 9, or 27 per cent, in adult bones.

In analyzing the causes of failure to obtain end-to-end apposition we find again that delayed application of extension was the most important single factor, accounting for 43.75 per cent of the cases, improper application of the principle was second with a percentage of 33.35 per cent, and premature removal accounted for the remainder, or 18.75 per cent. Average time in Russell's extension was 24 days.

Eighteen, or 39.2 per cent, of the cases of this series presented from 5 to 25 degrees of improper alinement. Six, or 30 per cent, were in growing bones and 12, or 36 per cent, in adults. We have calculated the amount of improper alinement in degrees of angulation or deviation of the fragments from the normal weight-bearing line. The average angulation was 14 degrees, the deviation 10 degrees. In 15 there was some angulation, 11 posterior and 4 anterior. Ten cases showed some deviation, 6 being external and 4 internal.

In analyzing the causes of the failure to obtain and maintain proper alinement (Fig. 8), we find that delayed application accounted for only 27.77 per cent. Improper application of the principle was the main factor here and accounted for 61.11 per cent of the cases. Premature removal of the apparatus came last with a percentage of only 11.11 per cent of the cases. The average number of days in Russell's extension was 22.

In summarizing we find that delayed application was the most important factor in our failures to overcome overlapping and obtain end-to-end apposition of the fragments. Improper application of the apparatus was by far the most common cause of failure to obtain and maintain proper alinement.

It is interesting to note that all of the factors mentioned are easily overcome by adhering strictly to the principles laid down by Russell in his original paper. The Russell method of extension in fractures of the femur is described by him as follows:

> The apparatus shown in Figure 9 consists in a sling beneath the knee and horizontal traction on the leg. The arrangement provides that the pull on the leg shall be nominally modified by the friction between the pulleys and cords. The special apparatus required is as follows:
>
> 1. An ordinary head-to-foot bar that can be shifted laterally as required. This can be fitted to the ordinary four-poster bed; but a more convenient way is to use two uprights, one at the head and one at the foot, securely lashed to the bedstead. The foot of the bed should be elevated to insure counter-extension by the weight of the torso.
>
> 2. An arrangement to which may be attached a couple of pulleys beyond the foot of the bed. These pulleys (Fig. 10) should be on a horizontal line with the foot of the patient when the leg is lying horizontally on the pillow with the heel just clear of the bed. A convenient wood or iron bracket can easily be made by the carpenter or the splint maker.
>
> 3. Four block pulleys and suitable flexible cord.
>
> Application of the apparatus. The use of an anæsthetist is not required in children. In muscular adults we have found spinal anæsthesia to be of the greatest advantage.—(Lee-Veal)
>
> 1. The leg, having been prepared in the ordinary way, is fitted with a spreader or block close to the sole of the foot by the method similar to that used in Buck's exten-

sion, although there are two important differences: (a) the strapping is not carried above the knee; (b) the spreader is provided with a pulley. A pattern of the spreader which we have found convenient is shown in Figure 12, but its essential feature is that it must be wide enough (5 inches) to deflect the strapping sufficiently to protect the malleoli from pressure. A light bandage over all, from the roots of the toes to the knee, is ready.

2. The application of the pulleys (Fig. 9). First pulley *A* is tied to the overhead bar in such a position that a vertical dropping from it shall meet the leg well below the knee. Pulleys *B* and *D* are to be attached separately to the bar beyond the foot of the bed; pulley *C* is attached to the spreader.

3. The knee sling is now placed beneath the knee, which all this time has been lying comfortably on a pillow. The sling should be broad and soft; a soft rough bath towel suitably folded answers well. The ends of the sling are now securely tied together with a cord, which is then passed through the pulleys in the following manner: (a) up to pulley *A;* (b) to pulley *B* beyond the bed; (c) to pulley *C* on the spreader; (d) to pulley *D* (companion to *B*).

4. The surgeon now stands at the foot of the bed and slowly applies extension to the leg and then the weight is attached. He next takes a soft pillow and adjusts it comfortably beneath the thigh to prevent gravitational sagging at the site of the fracture. Care must be taken that the pillow is really soft; a common fault is to have a too hard and tightly stuffed pillow for this purpose. Next he looks to the heel; it must not be touching the bed, and he arranges another soft pillow beneath the leg and the tendon of Achilles to prevent it from doing so. Now the patient will be absolutely comfortable and rest of mind and body (including thigh muscles) will come to him. Finally careful measurements are taken of the lower extremity, of the anterior superior spine, the upper margin of the patella on either side.

"The usual extension weight required for adults is 8 pounds; for infants and older children ½ to 4 pounds. These weights, it will be noticed, are doubled by the pulley arrangement nominally; but in fractures it would seem that there is considerable modification of the pull one way and another, and considerable latitude within the range of efficiency. The truth seems to be that a very moderate pull is adequate, provided it is fairly constant and comfortable. At the end of the third week Russell always seeks to reduce the weight. The surgeon's duty will be to take the measurements at least every morning and evening, and adjust the pillows beneath the thigh and leg so that there is no backward sagging at the site of fracture, and the heel shall not be in contact with the bed. Very little is required of him; but while it is very little and very easy, yet it is absolutely indispensable and must be faithfully given. The method is far from being 'fool-proof' and cannot and will not look after itself. The relation of the fragments should be checked by X-rays until reduction is obtained."

Again quoting Russell:

In surveying what one has thus accomplished, we find the thigh muscles are being extended by the combination of two forces. It is impossible to attain this by a single force acting in a straight line. The diagram (Fig. 11) will make evident the relative action of the forces employed. By constructing a parallelogram of forces it is seen that the resultant force will lie in the line of the thigh. Again, it will be noted that we have apparently taken no measures to secure and preserve good alinement; as bad alinement need never be seen in fractures treated in this way.

In his original report Russell states that experience has shown that the practice presents difficulties and pitfalls that have to be known and recognized, and what at first appeared to be small details in the management of the cords and the pulleys turned out to possess unexpected possibilities, and he, in a very valuable way, explains the causes of some of the poor results in this series of cases.

The most frequent of all errors, according to Russell, is that the foot is too high off the bed. The heel should be almost, but not quite, touching the bed. When the heel is too high a great part of the weight is employed in counteracting the weight of the limb, which, of course, subtracts from the extension on the thigh muscles. Upon examining the parallelogram of forces one will clearly appreciate that the horizontal force is diminished as the heel is raised above the level of the bed. Russell feels that this has been a very common error in his application of the extension. Another influence upon the efficiency of the extension and the reduction of the overlapping is in the faulty direction of the upward pull on the knee. If Pulley *A* is wrongly placed nearer to the head of the bed than it should be the result is an upward pull which causes the horizontal pulley to pull against instead of co-operating with it. The position of pulley *A* should be such as to increase the effect of the extension, and the change of its position frequently will make possible the complete reduction of the fragments, as in the Hodgen splint.

Another cause of failure to overcome shortening and restoration of the normal length of the bone is the use of too much weight. This is most frequently seen in children. If all the conditions which we have outlined, namely, position of the leg and foot in relation to the bed, the position of pulley *A* in relation to the knee joint, are such that the parallelogram of forces is as it should be, but the weight is excessive, we will find that the pelvis is pulled down on the injured side so that the patient lies very obliquely. When the pelvis is pulled downward, the limb is brought into a position of extreme abduction, when sagging of the fragments will occur and there will be shortening of the limb. (Fig. 289 of Russell's diagram, p. 500.)

Finally, the most momentous, according to Russell, of the difficulties is the interposition of muscles, or the thrusting of a fragment through muscle, periosteum or other fibrous tissue and its incarceration in such a way that the end of the fragment cannot be apposed. It is this type of case which he thinks requires immediate operation and open reduction.

Russell claims that there is only one kind of faulty alinement or angulation that is likely to complicate fractures when treated in this way, and that is the gravitational backward sagging at the site of the fracture. This he says is due to the lack of the most ordinary care, namely, the omission of the pillow support to the under surface of the thigh beneath the fracture. In our cases we found that anterior angulation in the upper third has been almost as frequent as posterior angulation in the middle and lower thirds, and although Russell claims that outward or inward deviation is practically never seen, we find that it has occurred too frequently in our group of cases. Our experience has coincided with that of Ridgely and Bongardt, that it is necessary to use more weight than Russell or Ryan employ. Twelve pounds of weight in adults is the minimum.

CONCLUSIONS

From this statistical study of a group of 51 fractures of the femur treated in five different hospitals, we feel that to obtain the maximum results from the Russell extension method in fractures of the femur one must:

1. Apply the extension at the earliest possible moment after the receipt of the injury. After 3 hours the efficiency of the extension is opposed by the contraction of the muscles and the effectiveness of the extension decreases from hour to hour.

2. That the extension must be applied exactly as Russell has prescribed.

3. That the position of the patient and every detail of the apparatus must be meticulously readjusted as soon as it becomes disarranged. In young children and in restless individuals this may require almost an hourly inspection. This is not peculiar to the Russell extension method, which is really a suspension apparatus, for such care is necessary in all methods of suspension used in the treatment of fractures. In our experience premature removal of the extension has been one of the most serious faults. Although Russell feels that 4 weeks is more than enough, it has not been so in our group of cases, and Lund reports that the average time of extension in his cases was 12 weeks.

4. In speaking of the results in any method of treatment of fractures of the femur one must remember that the type of the fracture and the site of the fracture probably have more effect upon the anatomical restoration of the lesion than any method of treatment, and that the spiral, comminuted and oblique fractures in the intertrochanteric region or in the lower third of the femur always give the highest percentage of anatomical restoration. In a review of the literature of the Russell extension method it is surprising to find how many of the reported cases are of these favorable types.

SUMMARY

We have deliberately tried to avoid the expression of personal opinions in this report, but Dr. Scudder tells us that in so doing we have failed to understand the object of the symposium. Therefore, for any criticism which we may receive for showing the same weakness that we have condemned in others Dr. Scudder must take the blame.

We plan to continue the use of this method in the treatment of fractures of the femur in children beyond the age (4th to 6th year) when Bryant's vertical extension is not applicable, and in the favorable types of fractures in adults, i.e., the spiral, oblique, comminuted, fractures occurring about the trochanters and in the middle and lower thirds of the femur. When we find that we are not succeeding we will quickly abandon this method for skeletal traction.

We will not attempt to use it in supracondylar fractures or in fractures of the upper third in muscular individuals.

The unfavorable results which we have obtained should, we feel, be credited to our failure to understand the principles of this method and to appreciate its limitations, and should not in any way be considered as condemning the Russell method of extension.

PATHOLOGICAL FRACTURES

E. L. ELIASON, M.D., F.A.C.S., PHILADELPHIA

A PATHOLOGICAL fracture is one occurring from an insignificant force acting upon a bone already weakened by disease. It is often spoken of incorrectly as being spontaneous in origin, which implies sudden apparent causeless occurrence. Each so called "spontaneous fracture" however, has a definite pathological basis. Each pathological fracture, depending upon its etiology, varies as to its treatment and prognosis. Pathological fractures caused by benign or chronic conditions have a favorable prognosis, as a rule, while those due to malignancy and acute suppuration, improperly treated, have an unfavorable one.

TABLE I.—PERSONAL SERIES

Bone disease	Cases	Per cent	Group	Group per cent	
Carcinoma	43	34.6	78	63.	Tumors
Sarcoma	15	12.			
Cysts	11	8.8			
Myeloma	7	5.6			
Hypernephroma	1	.8			
Endothelioma	1	.8			
Sarcoid	1	.8	16	13.	Infections
Osteomyelitis	12	9.8			
Lues	3	2.6			
Paget's disease	2	1.6			
Osteogenesis imperfecta	7	5.6	17	13.6	Nutritions
Rickets	7	5.6			
Osteomalacia	1	.8			
Hyperparathyroidism	1	.8	13	10.4	Miscellaneous
Atrophy	6	4.8			
Unknown	6	4.8			
Totals	124	100.	124	100.	

ETIOLOGY

Fracture statistics on the whole are deficient in complete analytical figures as to the relative causes of pathological fracture. Many cases originating as osteomyelitis, malignancy, etc., are overlooked or not reported because of the major interest of the etiological disease. Statistics relative to the incidence of disease in causing pathological fractures vary, too, with the size and type of hospitals. Speed states, for example, that at the Cook County Hospital he sees a large number of pathological fractures due to syphilis each year. His is a much higher figure than are those in smaller hospitals. Until a much larger number of these cases are available for study the knowledge of pathological fractures will be largely individualistic. Table I depicts a personally collected series from two hospitals. From this series it will be noted that bone tumors, benign and malignant, occupy the most important rôle in the production of pathological fractures. At the same time it is unfortunate that the entire subject of bone tumors is one which is so controversial. Often the diagnosis must be made on the X-ray film, frequently with uncertainty. Indeed, the microscopic diagnosis of a questionable lesion, even in the hands of the best pathologists, is often a difficult one to make. Considerable strides, however, are being made by the Committee on the Registry of Bone Sarcoma and others and today much more dependable figures are at hand than was the case when the writer presented this subject three years ago.[1]

Speed finds malignant disease to be the most common cause of pathological fracture. This is indirectly confirmed by Christiansen, who, analyzing 1000 cases of bone tumors (disregarding fractures for the moment) found 918, or 91.8 per cent, were malignant (Waring). Judging from the personal series and from the observation of others, it is probably quite safe to say that bone tumors (malignant and benign) are the chief cause of pathological fracture, inflammatory changes second, nutritional disturbances third, and neurotrophic changes fourth (Table I).

INCIDENCE OF BONE INVOLVEMENT

The incidence of pathological fracture is found to be greatest in the long bones connected with the trunk. The femur apparently suffers most. The humerus, tibia, and radius are the next most often fractured. The statistics of others approximate the personal ones given below.

In addition to the pure physical causes governing the bone involved, there is also an anatomico-pathological combination that makes for fracture-site incidence. Bone disease, which leads to pathological fracture, is found more often in the long bones than in the flat. The cancellous portions are frequently affected. Certain bone lesions tend to appear in the epiphyseal portions, rather than in the shaft, and consequently muscle action, greatest near a joint, accentuates any force upon the potentially weak part.

In an incomplete, personal series, we find the bones most affected by pathological fracture to be as shown in Table II.

Bone metastasis from organic malignant disease may occur in flat or long bones. Flat bones are seldom subjected to trauma, except by direct

[1]Eliason and Wright. Surg. Clinics N. America, vol. x, 1335.

TABLE II.—PERSONAL SERIES

Bone involved	Cases	Per cent
Femur	60	48.5
Humerus	21	16.9
Multiple	8	6.7
Tibia	7	5.6
Pelvis	6	4.8
Radius	6	4.8
Radius	5	4.
Vertebrae	2	1.6
Metatarsals	2	1.6
Phalanges	2	1.6
Clavicle	1	.8
Ulna	1	.8
Fibula	1	.8
Mandible	1	.8
Os calcis	1	.8
Totals	124	100

Fig. 1, left. Bone cyst or osteitis cystica fibrosa with fracture. Boy, 8 years old. Insignificant fall. Roentgenogram shows typical lesion of a large bone cyst involving upper third of humerus, through which there has occurred a pathological fracture. The cyst has produced some thinning of the cortex, but shows little tendency to expansion of the bone. The apparent trabeculations are evidently fractured portions of the thin bone shell. It begins as a medullary process, is osteolytic, usually single, does not invade the soft parts, and appears nearer the center of the diaphysis than does giant cell tumor, which hugs the epiphyseal area.

Fig. 2. Bone cyst with fracture and union. Same patient as in Figure 1, 2½ years after fracture. The X-ray shows the bone practically restored to normal. There is slight deformity and some increased thickening of the cortex with sclerosis at the site of the fracture. It is interesting to note that the healed fracture site is much farther down the shaft of the humerus than was the cyst 2½ years previously.

force while long bones are subject to direct and indirect forces; the latter includes torsion and weight bearing as well as muscle play. One seldom sees a pathological fracture of the skull, ilium, bones of the face, carpus or tarsus.

In 13,055 fractures at the University Hospital up to August 1, 1932, the pathological incidence was 0.42 per cent.

AGE AND SEX

Pathological fracture occurs most often in the extremes of life and is determined largely by the disease which predisposes to the fracture. Nutritional defects as rickets and scurvy, for example, occur in youth, likewise do bone cysts, giant cell tumors, and osteitis fibrosa cystica. Sarcoma occurs in youth and early adult life more often than in the aged, while carcinoma and neurotrophic or atrophic changes occur oftenest in late, middle, and advanced life. Acute infectious conditions occur in the first age period —1 to 20, whereas the chronic infections do not discriminate. These factors are more intimately referred to under their respective headings later. It may be well to note at this time that the prognosis, as a rule, is better in the younger patients than in the older ones. One might even say that the younger the patient and the earlier the disease (with but a few exceptions), the better the prognosis, and the older the patient or the longer the period of the disease, the more dubious is the final hoped for result.

CLASSIFICATION

For reference purposes we have classified the fragility of bones under three major headings. Fragility is generally due to a local lesion, a systemic affection, or an hereditary diathesis.

Fragility due to local lesions. Bone cysts. The first under consideration is local cystic disease of bone. Under this heading are included osteitis fibrosa cystica (giant cell tumors, bone cysts, etc.) Blood or dentigerous cysts of the jaw, hydatid and actinomycosis cysts and endochondromata of the phalanges and metacarpals are likewise included by some (French, Waring). Primary cysts will be considered first. Blood cysts are found in degenerating sarcoma (French). Hyda-

TABLE III.—CLASSIFICATION

a. Fragility due to local lesion:
   1. Tumors:
      Benign—cysts (osteitis fibrosa cystica), enchondroma, thyroid.
      Malignant—carcinoma, sarcoma, hypernephroma, endothelioma, multiple myeloma.
   2. Infections:
      Acute—Calvé-Perthes, Kœhler's, Kuemmell's, Keinboch's and Osgood-Schlatter disease.
      Chronic—tuberculosis, syphilis, Paget's.
   3. Chemical and pressure causes.

b. Fragility due to general disease:
   1. Neuropathic.
   2. Senility.
   3. Osteoporosis of disuse.
   4. Osteomalacia, rickets, scurvy, etc.
   5. Metabolic disturbances, diabetes, hyperparathyroidism.

c. Fragility due to hereditary disease:
   1. Osteogenesis imperfecta.
   2. Osteosclerosis (marble bones).
   3. Gaucher's splenomegaly.

Fig. 3A. Fig. 3B. Fig. 4.

Fig. 3. Metastatic carcinoma. Woman aged 52 years, primary lesion in the breast with generalized bone and visceral metastasis. Note the "decayed wood" appearance of the lesion before the fracture occurred, A. B shows the fracture 8 weeks after the insignificant trauma. Abundant callus is present and union is solid. Carcinoma of the breast causes frequent metastasis to the bones. It is a destructive process, usually beginning in the medullary canal and gradually increasing in size and destroying the cortex. It may ultimately weaken the shaft to allow a pathological fracture. Carcinoma of the breast very frequently causes the osteolytic type of metastasis but it may cause the osteoplastic type.

Fig. 4. Osteogenic sarcoma. R. R. 38, female, with a history of pain and swelling in the left lower thigh for 10 months. Osteomyelitis suspected because of the duration. X-ray picture showed pathological fracture, diagnosis osteogenic sarcoma. A second picture taken 7 weeks later showed a moderate increase in the area of bone production about the pathological fracture with an increase in the soft tissue involvement about the lesion. Lesion apparently is progressing. No union. Microscopic diagnosis—sarcoma. Osteogenic sarcoma is a malignant disease usually occurring in the large bones, more frequently in the upper tibia and lower femur. It occurs between the ages of 10 and 20 years. It is usually an osteolytic process, beginning in the medullary canal or from the periosteum. It does not cause expansion of the bone but causes destruction. It evades the surrounding tissues. When it is of periosteal origin, it very frequently causes a perpendicular striation of the new bone formation. The destruction of bone very frequently leads to a pathological fracture.

tid cysts are uncommon in America, but may be present in individuals who have lived in countries where the disease is prevalent (Russia, Armenia, and the East). Such cysts affect the diaphyses of the long bones as a rule, and convert the shaft into a thin walled tube which undergoes fracture as a result of slight trauma or muscular action. The existence of such cysts would hardly be suspected unless there were known hydatid disease elsewhere, especially in the liver. Cysts of the jaw or dentigerous cysts may be the site of fracture. Landois has pointed out that cysts due to echinococcus, cysticercus, actinomyco s or chronic osteomyelitis of bacterial origin ma re- sult in fracture. While fracture through si ple cysts often cures such cysts (osteotis fi osa cystica) fractures resulting from other typ of cysts usually require open reduction and ret- tage. Treatment other than immobilizatio will depend on the treatment of the causative f tor.

ig. 5. Hypernephroma. O. K. male, 59, presenting an pathological fracture of the left upper femur due to ernephroma (metastatic). Patient operated upon 5 rs previously for hypernephroma of the kidney. Three rs later developed pain in the left hip and suffered a hological fracture. One year later this had apparently ted and caused no trouble. Patient admitted for a rdotomy to relieve pain incident to metastasis to the bar spine. X-ray examination of pelvis showed an old hological fracture of the neck of the left femur, the neck he femur being absent and no union apparent. Metas- is present involving upper femur, pelvis, and lumbar ne. Hypernephroma frequently causes bone metastases. process is usually destructive and is very similar to found in metastatic carcinoma. At times, however, ecially in the vertebrae, it causes a condensing type of tastasis that may simulate prostatic carcinoma. Still, at er times, there are areas of rarefaction and condensa- n, showing a mixed type of cell in the metastatic process.

Fig. 5.

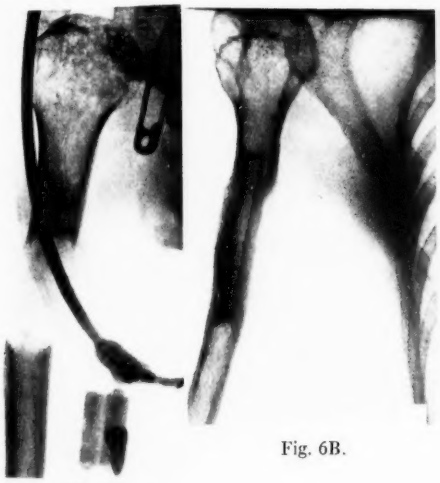


Fig. 6A.

Fig. 6B.

Fig. 6. Male, aged 32, with a history of neuralgic pains in his arm and shoulder for 18 months previous. On January 24, 1930, while steering a small car, he suddenly experienced a sharp pain and helplessness in his right arm. His physician diagnosed a fracture and the X-ray examination revealed the above described as a fracture through a bone cyst, myeloma or giant cell tumor. The X-ray picture, A, taken 3 months later shows extensive absorption of bone with no regeneration and no union of the fracture. The diagnosis now was sarcoma or Ewing's tumor, or giant cell tumor. A cortical lesion diagnosed as bone cyst was discovered in the shaft of the ulna of the same limb, other bones of the skeleton were negative for tumor evidence. The lesion of the humerus was excised and a fibula transplant resulted in an excellent union. The roentgenogram, B, was taken 3 years later. The microscopical diagnosis was angio-endothelioma.

Fig. 7A.

Fig. 7B.

Fig. 7. Multiple myeloma. The patient, a woman, aged 46, was receiving X-ray treatment for multiple myeloma involving the skull. Pathological fracture of left femur, followed few weeks later by fracture of right femur while being turned in bed. Union in both limbs. Patient subsequently had pathological fractures of spine, left humerus and left femur, union occurring in all the long bone fractures. Succumbed to bronchopneumonia. Multiple myeloma is a malignant process, usually occurring in individuals between 50 and 60 years of age. It involves, more frequently, the spine, ribs, and sternum. It is an osteolytic process, completely destroying the bone, beginning more or less in the medullary portions of the bone but may actually begin in the cortex. When it occurs in the spine, there is a widening and flattening of the vertebræ due to the loss of strain in the vertebræ, and stress and strain of the muscles. Pathological fractures occur very frequently. Multiple myeloma must be differentiated from metastatic carcinoma and parathyroid disease.

Fig. 8. Pathological fracture due to neglected osteomyelitis of 9 weeks' duration. Diagnosed rheumatism by the first physician. Abscess and fracture resulted. Condition spread to shaft and caused a second fracture. Amputation eventually performed. X-ray picture shows a fracture of the surgical neck of the humerus through a rarefied area which extends for a considerable distance down the medullary cavity of the bone. A low grade osteomyelitis showing but slight reaction to the infectious process. It is impossible to make an early X-ray diagnosis of acute osteomyelitis as it takes about 11 to 14 days to cause changes sufficient to justify one in making such a diagnosis. One should never wait for a positive X-ray report before making this diagnosis clinically.

Fig. 9. Acute osteomyelitis of femur with pathological fracture. Boy, 13 years old. Hurt thigh in football. Incision revealed an abscess; X-ray examination, a periostitis. Three weeks later present picture showed fracture. X-ray shows an oblique fracture at the junction of the middle and upper thirds of the right femur. The periosteum is elevated and thickened and there is an irregularity and mottling of the bone in the region of the fracture indicative of an acute osteomyelitis.

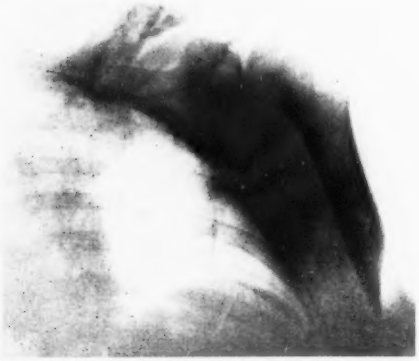


Fig. 10. Syphilitic osteomyelitis of clavicle with pathological fracture. Male, 32 years old. No injury. Fracture painless. Large spleen. Fifty neosalvarsan injections. Secured good union. X-ray examination shows generalized mottling of the involved portion of clavicle with increase in width of the bone due to the accompanying periosteitis with new bone formation. Osteomyelitis, due to syphilis, is slightly different from the usual osteomyelitis in that any periosteal proliferation assumes perpendicular striation whereas in ordinary osteomyelitis the periosteal proliferation is laid down parallel to the shaft. Syphilitic osteomyelitis, just as in the other type of osteomyelitis, is a proliferative and destructive process, which is always subject to fracture due to the weakened condition of the bone.

Fig. 12. A, Paget's disease with pathological fracture of femur. Female, 73 years old. While standing, leg "gave way"; very slight discomfort. X-ray shows marked thickening of the cortex and irregular areas of bone density, widening of the medullary canal and increase in the width of the bone trabeculæ. X-ray of the skull will usually confirm this diagnosis. B, Shows union ten weeks after Russell traction treatment. Note the dense callus formation. X-ray shows a pathological fracture in the right femur junction of the middle and lower thirds; fragments in good position; considerable bone callus at the site of fracture. The entire shaft shows diffuse, irregular areas of increased bone density. Considerable thickening of cortex throughout. The appearance is that of Paget's disease

Fig. 11. Sarcoid. J. C., 20, male, hospitalized for the treatment of malignant hypertension. No complaints referable to the hands and feet, though these were swollen, clinically suggesting gout. X-ray examination showed lesion involving the phalanges, metacarpals, and metatarsals, chiefly rarefaction. Diagnosis of sarcoid made. Four months later re-examination of the hands showed an improvement in the appearance evidenced by a recalcification especially in those areas previously showing the greatest decalcification. Pathological fracture of the proximal phalanx of the left ring finger evident at this time. Patient came to autopsy subsequently. Pathological examination of tissue removed from affected bones is typical of sarcoid. Sarcoid is a low grade tuberculous infection involving mainly the bones of the hand and feet, especially the phalanges. It may involve the cortex and medulla. It is necessary for this condition to be differentiated from Yaws or syringomyelia and possibly, smallpox. The process is usually in the ends of the phalanges and invades the joints. It is a destructive process.

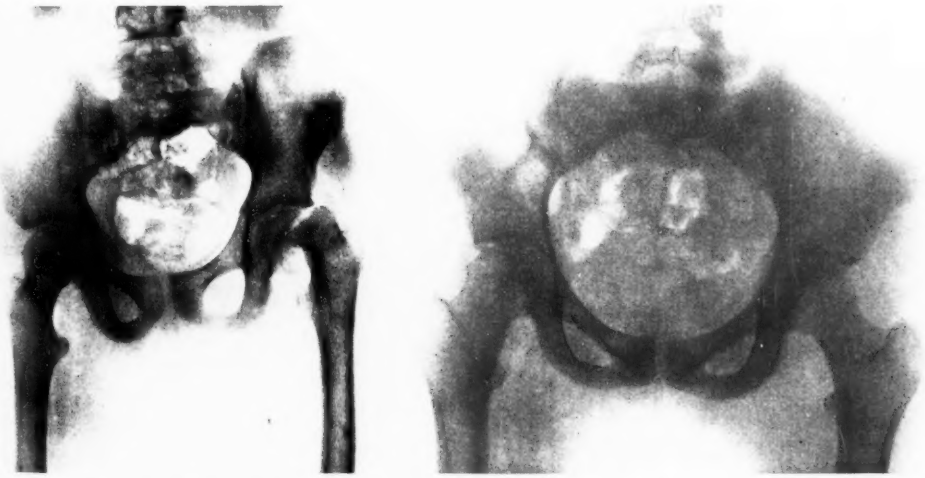


Fig. 13. Osteochondritis juvenalis femoris; girl, aged 11, in June began limping. In August an X-ray examination was reported negative. No pain. In December, 4 months later, while walking on a level pavement, the limb gave way with resultant slight pain. X-ray at this time revealed an epiphyseal separation, with diaphyseal bone vacuolization, A. Left, Diagnosis: osteochondritis. Roentgenogram. B, taken 1 year later shows perfect union as well as recovery from the inflammatory condition. Note: Examination of the first (August) X-ray film reported negative revealed a "slipping epiphysis with vacuolization or moth eaten appearance and absorption of the diaphyseal border."

Fig. 14A.

Fig. 14B.

Fig. 15.

Fig. 14. Giant cell tumor of the lower radius. Male, 19 years old, while receiving radiotherapy had to be splinted indefinitely. Note atrophy of disuse of phalanges. Had ulnar neuritis from pressure. X-ray picture shows a large tumor involving the lower portion of the radius. It has the characteristic trabeculated or "soap bubble" appearance of giant cell tumor. There has been a gradual expansion of the cortex which is everywhere intact. Note the abruptness with which the tumor stops in its upper portion, thus indicating its benign character. There is a fracture through the head of the fifth metacarpal, evidently from atrophy of disuse. Further, note the pressure absorption in the ulna opposite the radial tumor.

Fig. 15. Giant cell tumor. Clinical and X-ray impression was giant cell tumor. This was confirmed at operation 3 months later and the cavity was filled with bone chips. Two years ago the patient fell while bathing and injured the lower left femur. X-ray examination showed a fracture, pathological in nature, through the inner condyle of the lower left femur. Giant cell tumor is usually single, but may be multiple and is a benign lesion. It occurs in the ends of the diaphyses and in the epiphyses, most often between the ages of 20 and 30 years. The lower end of the radius, tibia, and fibula are the usual sites of this lesion. It is a medullary osteolytic lesion which grows gradually and expands the bone. It is frequently found entirely by accident, secondary to a pathological fracture. The process expands the cortex and does not invade the soft tissues.

Chondroma or enchondroma. Chrondromata of bone are benign though those connected with soft tissues may develop into chondrosarcomata. They usually form at an epiphyseal line and extend distally—expanding widely as they grow (French). The phalanges are the commonest site, but the lower end of the femur, the great trochanter, and upper end of the humerus, may also be affected. Though usually found in the long bones, Babcock states that they may locate about the hip joint, the neck of the scapula, and about the glenoid fossa. They are slow in growth, frequently multiple, and may be peripheral or central. Unless excised, the bone is gradually destroyed and a pathological fracture results. There is no predilection as to sex or age except that the lesion does not usually occur after middle life. When the condition is brought to the attention of a surgeon only after a pathological fracture has occurred, it is necessary in the larger long bones to excise the enchondroma prior to immobilization before union will take place. Shortening may result in small bones, as the phalanges.

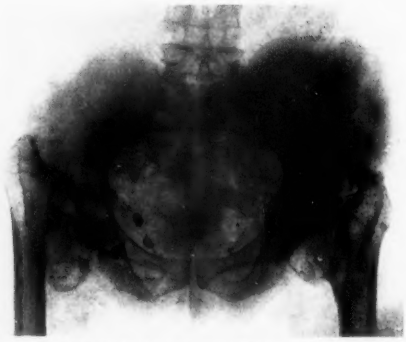


Fig. 16. Pathological fractures of the neck of both femurs due to Charcot's joints. Male, aged 52 years. Slight painful swelling for one year. No trauma. Walking on arrival. X-ray shows evidence of an old fracture of the neck of each femur with marked upward displacement of the shaft. The acetabula are shallow and rarefied. The head of each femur is flattened and also shows rarefaction. These fractures never unite. The X-ray appearance of Charcot's joint is one in which there are considerable hypertrophic and atrophic changes with loose body formation. The destructive changes and hypertrophic changes are out of proportion to the discomfort of the patient. This process, especially when it involves the hip joint leads to a pathological fracture of the neck of the femur.

Osteitis fibrosa cystica. By far the greatest number of pathological fractures due to cystic disease of bone is the result of osteitis fibrosa cystica. About this term and several others connoting the same condition (osteitis fibrosa, fibrous cysts, bone cysts, cystic disease of bone, fibrocystic disease of bones, von Recklinghausen's disease, etc.) lies a certain amount of confusion. Geschickter and Copeland have recently clarified the situation somewhat. They have reviewed 400 cases of bone tumors of the giant cell group, including giant cell tumor, osteitis fibrosa, solitary bone cyst, and are of the opinion that the three are one and the same condition in different stages and all due to trauma. The condition occurs most often in youth and at the metaphyseal regions of the long bones, chiefly the humerus, femur, tibia, and radius. A fracture from slight violence is frequently the first intimation of trouble. The X-ray findings are characteristic (Fig. 1). The fracture is not very painful, is often

Fig. 17 A.

Fig. 17 B.

Fig. 17. A, United pathological fracture of neck of femur due to osteomalacia. Female, aged 23 years. Fractured hip when 9 years old and femur when 19 years of age. Concave cortex is thick. X-ray film shows an old united fracture of the neck of the femur with consequent deformity of the hip joint. There is marked decrease in density and a loss of the normal bone trabeculations as compared with the opposite femur. B, The shaft distal to the trochanters shows bowing with thickening of the cortex on its entire inner aspect evidently the result of faulty weight bearing in an osteoporotic bone.

Fig. 18.

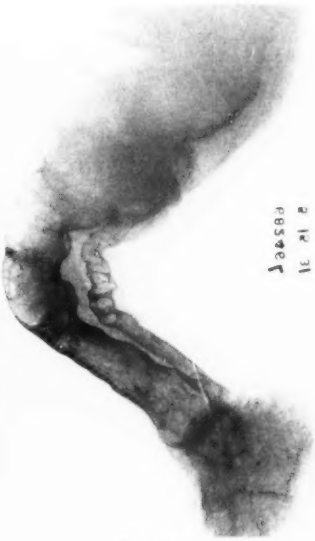


Fig. 19.

Fig. 18. Rachitis. C. P., male child, 29 months old, with a pathological fracture of the shaft of the left femur due to rickets. Normal delivery, bottle fed baby, no cod liver oil or viosterol. Walking delayed until age of 2 because of a club-foot, present at birth. Injured left limb from trivial trauma at play. X-ray film showed typical signs of rickets. Treated by suspension, Bryant's method. Good union in 1 month. X-ray film on discharge showed evidence of healing rickets in both lower extremities. This is a deficiency disease of the bone. The process is osteolytic in type; involves multiple bones. It is usually seen in children after the age of 4 months and is supposed to be due to vitamin deficiency. It is a benign process which heals by regulation of the diet and vitamins. When fractures occur, they usually occur near the epiphyseal line where the (Rickets) bone is weakest due to the osteoid tissue. The X-ray appearances in a typical active case shows disappearance of the center of ossification in the epiphyses, widening, and cupping of the diaphyseal end which expands with the enlarged epiphyses; osteoid zone at the ends of the diaphyses and disappearance of the zone of temporary calcification.

Fig. 19. Hyperparathyroidism. The photograph is that of the lower extremity of a young man, from whom on three occasions a parathyroid adenoma was removed. The patient has had countless fractures over his entire skeleton. The X-ray film shows the pronounced widespread decalcification and ofttimes a pathological fracture. The patient did not have a recent fracture at the time of this exposure.

Fig. 20.A. Fig. 20B.

Fig. 20. A, Multiple pathological fractures of right femur and bones of both legs due to osteogenesis imperfecta; 13 month old girl, one of twins. Both suffered similarly. X-ray film shows marked deformity of both lower extremities due to multiple fractures of the femora and tibiæ. All the bones show the generalized decrease in bone density characteristic of osteogenesis imperfecta. It is an osteolytic process evidenced by decreased density of the bones, thinning of the cortex, and multiple fractures. The fractures unite with considerable external callus formation. These twins had been on orange juice and milk under the supervision of a children's clinic previous to admission with the fractures. In the hospital the treatment consisted of orange juice, cod liver oil, heliotherapy and traction. B, Sixteen months after intensive treatment. Both twins have had no further fracture for 3½ years. X-ray film shows practically normal lower extremities. The deformities have disappeared; there is little or no evidence of the previous fractures. Note the marked increase in bone density.

Fig. 21.

Fig. 21. Gaucher's disease. Female, aged 9 years, was observed over a period of 4 years during which five pathological fractures were treated. At the age of 5, child was hospitalized with a fracture of the upper right tibia and of the left femur. Satisfactory union. Tentative X-ray diagnosis, Gaucher's disease. At the age of 6 years, had fracture of neck of right femur, satisfactory union. At the age of 7, child again had pathological fracture of the neck of the right femur while walking. Union satisfactory but considerable lateral bowing followed this injury. Child was treated by diet and viosterol during this period. Fracture of the left humerus at age of 8, good union. At present there is considerable anterior bowing of left humerus and the right leg which is shorter than the left shows marked anterior bowing of the femur. X-ray studies of the skull show diffuse areas of rarefaction and areas of increased density, the lesion increasing steadily. The blood calcium is 10.5 milligrams.

comminuted although with little overriding, and union occurs, usually with a resultant cure of the cystic condition. Follow-up reports have shown, however, that, at least in some cases of fracture, irradiation has given the most lasting cures, probably because of parts of the cyst having escaped the curative trauma of the fracture.

Metastatic carcinoma (Fig. 3 A and B). Carcinoma of bone is metastatic, or the result of invasion from an overlying tumor. It is well known that carcinoma, especially of the breast tends to produce bone metastases. Carcinoma of the stomach may also give rise to secondary deposits in the bones. Waring found that metastasis to bones occurred in 53 cases (4.6 per cent) of 1,144 autopsies upon cancerous patients. Of the 53 cases, 34 (64 per cent) were carcinoma of the breast primarily. The first signs of malignant disease may be osteoporosis, erosion, and fracture, although pain frequently calls attention to its condition. Usually more than one bone is involved. Unlike sarcoma, the bone lesion is rarely large enough to command attention and the growth is slow. A moth-eaten or "decayed wood" appearance with a compensatory periosteitis results. The common sites for metastasis, with fracture, are the femur, humerus, ribs, and sternum. Handley (Speed) in 329 cases of carcinoma of bone, due to metastasis from carcinoma of the breast, found the bone incidence as follows:

	Per cent
Sternum	9.0
Ribs	8.0
Femur	4.2
Spine	3.6
Humerus	2.7
Cranial bones	2.7

Handley states that in carcinoma union is the rule. Pancoast estimates that union occurs in probably 40 per cent of these cases with or without radiation.

The prognosis, of course, is very poor, as with other malignant bone affections. The local lesion causing the fracture is only an incidental part of the generalized malignancy. The prognosis is similar to that in sarcoma of which Ewing remarks: "The surgical treatment of bone tumors is highly unsatisfactory." Amputation is seldom indicated from a curative point of view as it may be indicated in early cases of sarcoma. It may be performed for the patient's benefit to shorten his hospitalization and to free him from malodorous dressings, disability, and pain.

Sarcoma (Fig. 4). Sarcoma of bone is usually primary and of the osteogenic type. Pathological fractures occur and union after fractures is possible, but rare (Babcock). Waring has seen union occur, but Bloodgood has seen only one case in which union occurred and one other questionable case. Pancoast has no case of union in his files; Pfahler recalls no case with resultant union. Meyerding (see Waring) analyzing 109 cases of sarcoma involving bone, found the different types to be as follows:

	Cases
Mixed celled sarcoma	51
Osteosarcoma	19
Chondrosarcoma	17
Round cell	14
Fibrosarcoma	8
	109

Waring classified sarcoma of bones into periosteal sarcoma and endosteal or central sarcoma. The first should not be confused with parosteal sarcoma which is sometimes termed "periosseous fibrosarcoma." This latter is not a true bone tumor, but lies adjacent to bone and may by pressure affect bone without invading it.

Periosteal sarcoma is more common than endosteal. The metaphyses of long bones is the commonest site. Seventy-two per cent (Babcock) involve the lower extremity and 82 per cent of these occur near the knee. The shoulder girdle is next in frequency. The humerus is usually attacked above the deltoid tubercle, the scapula in its glenoid cavity or spine, and the clavicle in its outer one-half. Other bones may be involved, but are seldom fractured. The fact that the lower epiphyseal end of the femur and upper epiphysis of the tibia are the last to ossify may explain the predilection for this area (Babcock).

Trauma is said to precede 50 per cent of cases of osteogenic sarcoma and the tumor to develop within 1 month after injury in 30 per cent of cases. The bones concerned in the formation of the knee joint and shoulder girdle likewise receive a large share of trauma in the young, among whom it most often appears. Strangely enough the lower end of the radius (though often injured) is rarely affected and there is no record of the distal end of the ulna ever being involved.

Males are affected in the proportion of 3 to 1, though females predominate during the first decade of life. Sarcoma of bone occurs chiefly in childhood before the age of 20 years, and is rather rare after the age of 40, except where it is secondary to Paget's disease. According to Codman (Babcock) 14 per cent of all patients with Paget's disease die of osteogenic sarcoma.

The X-ray picture of the lesion is generally characteristic. There is a fusiform swelling or spindle contour at the end of the bone. The joint or epiphysis is not invaded. The periosteum becomes markedly elevated with a thickened "lipping" of its margin. In 18 per cent there may be noted fanlike radiations which give it the so-called "sun-rays" appearance. Expansion of the shaft rarely takes place. The spindle mass is caused by penetration of the bone by the tumor and the formation of a mass around the shaft.

Treatment is more hopeless when a pathological fracture occurs than otherwise. By the time the surgeon sees the case the resulting trauma to the tissues has opened the blood and lymphatic vessels, thus predisposing to metastasis. The mixed toxins of Coley, irradiation and amputation, are reported to have cured some cases of sarcoma, but rarely so when fracture occurs. Cases thought to be cured of their local lesion by irradiation generally die later from metastasis. By the time the bone is involved sufficiently to result in fracture, dissemination has either begun or occurs with the injury to the tissue at the time of fracture.

The writer has successfully treated 2 cases by amputation. One was in the distal portion of the femur and one in the tibia. Both diagnoses were proved by the microscope. One case is alive at the end of 18 years and the other at the termination of 12 years. There is no doubt that amputation is of value only when the condition has just begun and when it is distally located. A high amputation

may then be successful. Coley has recently reported 2 cases of the endothelioma type with apparently successful cures by operation and the use of Coley's fluid. One patient was well 3 years later and the second 4½ years after. Coley and Sharp state that fracture through osteogenic sarcoma shortens life expectancy 60 per cent.

Statistics show (Ewing) that nearly all osteogenic sarcomata prove fatal, and while recovery seems to have occurred in rare cases "this fortunate outcome is the meager fruit of large numbers of useless amputations." However, amputation in many instances has its advantages. It shortens the hospitalization of the patient. It relieves the patient of an incapacitating, often painful, frequently ulcerating, foul smelling lesion requiring painful dressings. Furthermore, after such operations patients have been known to live with comparative comfort for many months despite the presence of visceral metastasis (lungs) at the time of operation.

Endothelioma (Figs. 5 A and B). An endothelioma is a tumor originating from endothelium and resembling both sarcoma and carcinoma. It forms about 7 per cent (Babcock) of the sarcomata of bone.

It affects the long bones more often than the flat. The most common sites are the tibia, fibula, humerus, ulna, and the femur. Other small bones of the feet, ribs, vertebræ, etc., may be affected. In the latter locations it must be differentiated from multiple myelomata. The tumor widely involves the shaft of the long bones or starts in multiple areas. The tissue itself is soft, mushy, and whitish gray. While it destroys bone a regenerative process likewise takes place at the periosteal borders. Various layers are formed in the course of time giving the roentgenogram the peculiar appearance termed "onion layer" (Babcock).

The disease frequently follows trauma and is usually one of youth, 50 per cent of the cases occurring before the age of 15 years. Because of the pain, limitation of motion, slight fever and leucocytosis, it may be mistaken for osteomyelitis. The joint is seldom involved and pathological fracture occurs late.

Metastasis via the blood or lymphatic stream occurs with great rapidity in the lungs, skull, various bones, liver, spleen, and regional lymph nodes.

The prognosis is very poor as death generally occurs in from 6 months to 2 years. The disease is very sensitive to irradiation.

Treatment consists of immobilization and possibly irradiation. Union may occur as temporary improvement or retrogression takes place with radiotherapy. If the condition occurs in an extremity and is recognized before metastasis takes place, amputation in our opinion should be done.

Hypernephroma—metastatic (Fig. 6). Hypernephroma is now considered to be a malignant adenoma or adenolipoma of the kidney. It occurs generally in young girls and in adult men. The condition is extremely malignant and metastasis occurs via the blood stream to the liver, lungs, and bones. The bones most often affected are the skull, humerus, and femur. Cases have been recently reported by Mazzini, MacKechnie, and by Broster. Rapid recurrence generally follows extirpation of the original tumor. Excision or amputation, when pathological fracture occurs, offers no hope of cure. Death usually occurs in from 2 months to 2 years. Radiotherapy and Coley's fluid may be tried. The prognosis is more grave than that of a pathological fracture due to sarcoma.

Thyroid—metastatic. Bloodgood states that the majority of these lesions are metastases from a malignant adenoma of the thyroid gland, although other authorities consider the condition non-malignant. Blumer has analyzed the reported cases and finds that 38 per cent occur in the bones of the face and cranium, 16 per cent in the vertebræ, and only 15 per cent in the long bones—hence fracture is comparatively rare.

Multiple myeloma (Figs. 7 A and B). Myelomata, in comparison with the single benign myeloma of bone, are multiple, malignant, and subject to metastases. Fortunately, the condition is rare (Waring). The bones most commonly affected are the ribs, sternum, vertebræ, cranium, ilium, and (very rarely) the long bones of the upper extremity. Often the first symptom is pain in one of the areas most affected. As the disease progresses metastases take place in other bones. When the spinal column is affected the pressure on the cord may resemble that of a spinal cord tumor. Pathological fracture is seldom seen as the flat bones are oftenest involved. Anæmia is sometimes present. Males, generally between 4 and 60 years of age, are most likely to be affected. The prognosis is very poor as death usually occurs in a few months. Surgery or radiation is of little value because of the widespread metastases. Treatment is directed to immobilization, sedatives, and attending complications. Union does occur, proved by the case illustrated in Figure 7.

Infections. The infectious diseases of bone leading to pathological fracture are subdivided into the acute and chronic.

Acute pyogenic infections (Fig. 8). Acute osteomyelitis may form a localized abscess involving a large portion of a bone and lead to fracture. As a rule, however, more extensive destruction takes place with a resultant periosteitis, necrosis, sequestrum formation, and pathological fracture. The first two decades of life (males particularly) are probably more often affected than any other. The condition is sometimes erroneously diagnosed rheumatism, subdeltoid bursitis, etc. This is understandable when X-rays taken at the beginning of pain may be negative for bony pathology. The treatment is essentially that of an infected compound fracture, namely adequate drainage plus immobilization. When such cases come to the surgeon early the prognosis is good. In neglected cases, non-union may occur, particularly when improper splinting has been applied. Union is the rule in pathological fractures due to acute osteomyelitis where early drainage has been secured. Excessive callus is often seen.

Chronic infections—syphilis (Fig. 10). Syphilitic disease of bone *per se* is seldom a cause of pathological fracture. Such fractures, though, occur fairly often in patients with cerebrospinal syphilis.

The local affection of bones is generally a periosteitis which results in a thickened cortex and osteosclerosis. Nodular swellings may occur as in "saber shin." Subperiosteal gummata may destroy bone and weaken it sufficiently to cause pathological fracture. This is particularly true where an ulceration or infection is engrafted upon a secondary osteomyelitis. Constant has reported pathological fractures of the femur due to syphilitic osteomyelitis. Silhol has reported a similar case with recurrence. Achard and Walter have made a study of clavicular fractures in syphilitics. Figure 10 shows a personal case.

Chronic infections — tuberculous osteomyelitis. These affections are often seen in the phalangeal, tarsal, and carpal bones of children as strumous dactylitis. There is a localized fusiform swelling of a phalanx or metacarpal bone, caused by a tuberculous caseous process that breaks through the cortex. In adults, a diffuse thickening from periosteitis and the formation of a central sequestrum occurs. With necrosis, a pathological fracture may take place.

The disease attacks long bones in the region of the epiphyses. The short long bones are usually affected nearer the shaft center. The femur, tibia, humerus, and bones of the forearm are the ones most often fractured. The ribs may be invaded by extension. Lenormant has reported pathological fractures of ribs in tuberculous osteitis.

In America the condition is on the wane, due no doubt to better milk laws. Innumerable cases of tuberculous osteomyelitis still occur in Turkey, the Balkans, and southern Russia, where the majority of cows are affected with bovine tuberculosis. The condition occurred most often before the age of eighteen.

Chronic infections—osteitis tuberculosa cystica multiplex (sarcoid) (Fig. 11 A and B). In this disease tubercle bacillus is the etiological factor. It manifests itself in typical skin lesions or in typical bone lesions, or in both. All the lesions are painless. Emaciation and weakness are pronounced. The bone lesions are limited to the hands and feet, chiefly in the phalanges but they do occur in the metatarsals and metacarpals. The X-ray changes consist of a slowly progressing alteration in the trabecular formation of the bone, followed by actual bone destruction, either central or cortical or both. In another type the lesions begin as punched out areas, sometimes extending entirely through the phalanges. Complete destruction is most likely to occur in the terminal phalanges. The disease is a chronic one and the tubercle bacillus is not always found nor is caseation ever present.

Sufficient information is wanting upon which to make any statement as to the incidence of union in pathological fracture in this condition.

Chronic infections—Paget's disease (Fig. 12A and B). Paget's disease is a condition of unknown origin and very likely due to an infectious process. It is a chronic, progressive, and symmetrical disease affecting chiefly the long bones, skull, and spine. Early hyperæmia, bone absorption and softening take place. These changes are followed by bending, thickening, sclerosis, and a tendency to sarcomatous change.

According to Babcock the marrow first becomes vascular and the bone, rarefied and partially decalcified, bends under pressure. Later excessive bone formation occurs with calcification and sclerosis. It is during this latter stage that pathological fracture is most apt to occur.

The curved legs, bowed knees, kyphotic spine, and anthropoid carriage attest the progress of this incurable disease. The femur and humerus are the bones most liable to fracture. The fracture line itself is characteristic, and generally is clear cut, transverse, or of the "step type." Union occurs, but is slow and prolonged immobilization is required. Excessive callus is the rule.

The progress is favorable as far as eventual union is concerned, but it is grave inasmuch as 14 per cent (Codman) of the patients die of a secondary osteogenic sarcoma. "If there were

non-union of a fracture in a bone, evidently an example of Paget's disease, I should be suspicious of secondary sarcoma and amputate at once" (Bloodgood). The presence of osteogenic sarcoma in later life is almost presumptive evidence (Babcock) of Paget's disease. Recurrent fractures are apt to follow.

During the progress of the general disease the skull becomes extremely thick and the intracranial space decreases. As a result, severe headache, cerebral pressure symptoms and mental deterioration take place. In the elderly, softening of the fractured ends may develop into sarcoma.

No cure for Paget's disease has been discovered. Parathyroid, thyroid, calcium therapy and irradiation have been tried with indifferent and variable results. As the condition is often ushered in with a slight fever, dull aching pains, and hyperplasia of bones it is not without hope that some one may yet discover an infectious agent to be its cause and a subsequent cure result.

Fragility due to infection of epiphyseal areas (Fig. 8 A and B). The following conditions fall into this category:

Osteochondritis deformans juvenilis coxæ results in pathological separation of the epiphysis of the head of the femur (slipping epiphysis) and produces deformity and shortening unless detected and treated early. Immobilization in a Whitman cast and prevention of too early weight bearing afterward suffice for a cure. The prognosis is good.

The slipping tibial tubercle described by Osgood and Schlatter, and seen most often in rapidly growing male adolescents, might well be grouped here. The condition is readily recognized if one is on the look out for it.

Koehler's disease, Kuemmell's disease, and Keinboch's disease might be classed as pathological fractures if we consider trauma as the etiologic factor.

Local pressure (Fig. 14). Local pressure on bone may lead to necrosis and subsequent pathological fracture. Some of these causes are: Pressure upon a contiguous tumor, pressure upon ribs, sternum, or vertebræ, pressure from a tight encircling wire or metallic band. The treatment consists of removal of the cause when such is possible. A personal case is recorded in which the fracture was due to pressure necrosis resulting from the application of a Parham-Martin band in another hospital. Garr has reported a similar case. Kilgore and Chamberlain have reported "fibrosarcoma of soft parts causing pathological fracture of the femur and giving an X-ray appearance of periosteal sarcoma." A double fracture of the mandible predisposed by an impacted molar has been described by Crich.

Fragility due to general disease. Neuropathic (Fig. 16). There are certain diseases affecting the central nervous system in which pathological fractures occur. The most common are tabes dorsalis, paresis, syringomelia, spina bifida, hemiplegia, and infantile paralysis.

The exact cause of predisposition to fractures in these conditions is not as yet known. No doubt there are several. It is known that injury to a nerve supplying a part causes trophic disturbances. An atrophic bone readily fractures. Allison and Brooks have shown that bone atrophy of disuse is a quantitative rather than a qualitative chemical change. The chemical constituents of the bone making for strength and elasticity are deficient. The bone is fragile and it breaks easily. Other accessory factors, such as loss of pain and sensation, weak, atrophic musculature, and hypoplasia of bone, may play a part.

Neuropathic—tabes dorsalis and paresis. The greatest number of pathological fractures in syphilitic patients occurs in tabetics and in paretics. According to Speed "the nervous system also has on bone an influence which predisposes to fractures. Neurotrophic influences in insanities, in paralyses, and particularly in tabes must be considered. In the Cook County Hospital there are each year 12 to 15 cases of pathological fracture or fracture dislocation in tabetics. They are usually near the joints, accompanied by much bone change of a rarefying or hypertrophic character of typical Charcot joints, and are quite painless. Some patients present three to five fractures at the same time."

Cotton is of the belief that "fractures in tabetics are hardly spontaneous; they depend on incoordinate but powerful muscle action (as in fractures due to feats of strength), for, contrary to the common statement, the bones of tabetics are apt to be heavy and hard rather than atrophic."

Pathological fractures in paretics usually occur late in the disease when these patients are bedridden and their paralyzed extremities are in an atrophic stage. False claims (French) of rough handling by attendants may be made. The femur is probably most often affected; occasionally the clavicle may also be affected. The diagnosis rests partly upon the history, physical findings, blood or spinal Wassermann test, and the X-ray picture.

Treatment consists of proper immobilization, active antisyphilitic treatment, including large doses of iodides (Babcock), and drainage or dressings in cases of a "mixed infection" osteomyelitis.

The prognosis is good as a whole, particularly where the disease is local. Speed agrees that most tabetics, even with Charcot's joints, heal though with deformed, but nevertheless functioning, joints.

Neuropathic—syringomyelia. Fractures in this condition are usually observed in the upper extremities while tabes which simulates it somewhat generally causes fractures in the lower limbs. The patient may not recall any traumatic cause, being insensible to pain. Schultzer reports a baker who fractured his arm during ordinary kneading of dough. The patient felt no pain, but the crepitation and shape of his arm attracted his attention. A patient of Bernhardt's also sustained a fracture of the ulna while at work, but continued to break stones. The next day he even carried water before consulting a doctor. Schlesinger reports a woman who heard a crackling sound while turning a bed cover. She then found that she had fractured both bones of her forearm. Schultzer finds, curiously, that the right side is seldom affected and the lower extremities rarely.

The fractures are apt to occur only in the late stages of syringomelia. Normally they heal quite rapidly or may require a long time and pseudo-arthroses may form. The callus may be normal in amount or superfluous. It is the opinion of Schultzer that because of the loss of pain and muscle sense, the patient may not be aware that he is subjecting his muscles to any excessive strain. Similar instances are seen in normal individuals performing "feats of strength." Recent articles regarding pathological fractures occurring in this condition have been published by Koch and others.

Neuropathic—spina bifida. Pathological fractures in the lower extremity have been noted in cases of spina bifida. Its occurrence is not common. Its cause is attributed to bone atrophy as a result of the involvement of the lower spinal nerves in the meningocele. It may, however, be due to atrophy of disuse where the lower limbs are paralyzed. Where the neurotrophic condition has affected the growth of the bone, hypoplasia of bone rather than atrophy may occur. An 8 year old boy under our present care illustrates this.

Neuropathic—hemiplegia. Fractures due to bone atrophy and disuse usually occur in elderly hemiplegics. Often they are bedridden, though a defensive movement in an ambulatory case may result in fractures. The site of fracture is usually the anatomical neck or upper shaft of the femur. Occasionally the humerus suffers. Experience has taught us that the usual treatment of the past (plaster cast) is often inadvisable. As a general rule, the Russell apparatus is the most satisfactory treatment for fractures of the femur. It is best to keep the patient in semi-Fowler position.

The reasons that have led us to adopt this form of treatment are: The frequent occurrence of hypostatic congestion and pneumonia, and decubitus in cases treated with a plaster cast, difficult nursing care, delayed or non-union in many cases, regardless of the form of immobilization, and finally economical and functional considerations. The patient is elderly and bedridden. The extremity is paralyzed and functionless, with or without union. Why, then, restore bony alinement in a paralyzed extremity at the cost of life from complications? The time will come when useless limbs will be amputated.

Neuropathic—infantile paralysis. In either infantile spinal paralysis or the cerebral paralysis of children, the growth of the bones in the affected extremity does not keep pace with the normal side. Bone hypoplasia and a retardation of bone growth may accompany bony and muscular atrophy. Willard mentions bone atrophy following poliomyelitis. Hassin and his associates have reported a number of cases. The question is unsettled as to whether the lack of regenerative power of bone in cases of paralysis is due to disuse or trophic disturbances. Putzu found experimentally that nerve trunk lesions have no effect on the formation of callus. Others have reported differently. Allison and Brooks show the effects of disuse in the production of bone atrophy. Tumpeer and McNeely have recently reported 2 cases of fractures in poliomyelitis.

Delayed union and refractures are apt to occur.

Osteoporosis of disuse. Osteoporosis of disuse is essentially bone atrophy due to prolonged immobilization or insufficient motion in a part. Bone stability is apparently due to proper nutrition supplied by an adequate circulation or tissue respiration. When either of the latter is interfered with, decalcification results. Hypomotility decreases tissue respiration. This condition is frequently observed in extremities that have been overimmobilized or have not functioned because of paralysis. It is encountered in the extremities of hemiplegics, infantile paralytics, deltoid, musculospiral, and circumflex paralysis, etc.

The prognosis is good if there is no accompanying nerve paralysis, though in the aged, senile changes, etc. must be remembered. As a rule, early mobilization, diathermy, baking, massage and passive motions bring a good result. An unusual case is that of a young man (distal end of fifth metacarpal) who developed a pathological

fracture of his fifth metacarpal as a result of prolonged immobilization of the wrist (and possibly from nerve pressure) while being given radiotherapy for a giant cell tumor of the lower end of the radius.

Osteomalacia. (Fig. 8 A and B.) Osteomalacia is an abnormal softening of the skeletal system. It affects adults primarily. So called "juvenile osteomalacia" as a rule is osteogenesis imperfecta, with which it is often confused. In America, osteomalacia occurs most often in lactating women and is fairly common among those (Italian and Austrian) who are often pregnant, have a poor diet, and suckle their young for 1 to 2 years believing pregnancy can be avoided thereby.

War and famine osteomalacia was observed very often among the Central Powers during the great war. Maxwell (Peking, China) claims that osteomalacia is seen more often in India, Kashmir, and Northern China than in any other countries. In the latter place there are at least 40,000 to 50,000 cases, mostly found in the uplands of Shansi and Shensi, in the middle belt of Kansu and in Manchuria. It is occasionally found in isolated cases all over the Republic of China. Hunger or starvation osteomalacia, as it is also called, is due to a long continued improperly balanced diet. Lack of fresh foods containing vitamins and absorbable calcium has been found to be the cause. Recently we have observed this condition in a 28 year old female dietician, who, through voluntary dietary restriction to make herself thin, so succeeded that her tissues were those of a case of rickets. She was nearly 6 feet tall and weighed only 100 pounds. She was devoid of subcutaneous adipose tissue and the osseous system was quite porous. The fracture sustained was an intracapsular one of the femur with practically no pain. She has made an excellent recovery through immobilization, diet, and ergosterol.

The condition when due to famine affects naturally both sexes and all ages. The diagnosis is generally made by X-ray. When the disease has progressed for a long time before fracture, bowing of the femora and pelvic deformity may be physically observable. The roentgenogram of the fractured and other bones reveals osteoporosis. The degree of bone porosity varies with the stage or severity of the disease. The bones are lacking in calcium and the blood content of calcium may be as low as 5 to 6 milligrams (Mills and Feng). Bending of the long bones is often noted. It is due to weight bearing and bowstring muscle action.

The prognosis is favorable although union may be delayed if metabolic needs are not appreciated, and refracture may occur for the same reason. In addition to immobilization, treatment should be directed to the causative factor. In the case of famine osteomalacia, a normal diet should immediately be given. It should be reinforced by articles that can quickly make up the deficient bone regeneration. Food products rich in vitamins C and D should be given. These consist of milk, codliver oil, egg yolk, orange and lemon juice, apples, and bananas.

Administration of parathyroid (Collip) may be given a trial. New calcium, easily absorbable, must be supplied by diet. Codliver oil, viosterol, ergosterol, ultraviolet rays, or sunshine, aid in better calcium absorption and deposition. In lactating or pregnant women, it may be advisable to terminate lactation or pregnancy and immediately institute the calcium-increasing treatment outlined. The fetus in osteomalacia suffers with the mother. Osteoporosis and a diminished amount of calcium in the blood and umbilical cord are generally found. Maxwell, without terminating pregnancy, has been able to treat an expectant mother, cure her during gestation and normally deliver her of a normal child. He uses diet, codliver oil, and irradiated ergosterol.

Cases due to starvation or underfeeding have been reported by Simon, Steiner, Hahn and by Azenes.

Rachitis (Fig. 18). Rickets is observed most often in infants, but it may persist to adolescence. It is due to the lack of vitamin D. Negro children are probably most often affected. It is a hypovitaminosis, due to a poor diet on the part of the mother or an improper baby formula. In infants the fontanelles delay in closing. A rachitic rosary is often present. The epiphysis and joints are enlarged. Curving of the long bones results. The bones are deficient in calcium and phosphorus and often contain an abnormal proportionate amount of magnesium and sulphur. The bones are fragile because they are soft. Fractures are similar to those in osteogenesis imperfecta. The X-ray reveals, however, cupped epiphysis in addition to bone porosity. Multiple fractures and recurrent fractures occur when the condition is not recognized or vigorously treated. The prognosis is good under proper treatment. Excessive callus is often the rule.

The treatment consists of proper immobilization and attention to diet and vitamin requirements. If the baby is still nursing it should be taken from the breast and placed upon a proper formula. Orange juice, codliver oil, ergosterol, viosterol, etc. should be added. Schilowzen has demonstrated that avitaminosis retards the for-

mation of callus. When available sunshine and ultraviolet irradiation are extremely beneficial. Scurvy may attend the condition as it did a recent one of our own.

Scorbutus. Scurvy may occur at any age and in either sex. It is a hypovitaminosis and occurs when the diet is lacking in vitamin C. Imperfect osteogenesis results. Wasting, diarrhœa, mucosal hæmorrhages, periosteal proliferation, and osteoporosis are manifestations of the condition.

While it may occur among sailors, hunters, and explorers who exist largely upon canned or dried foods, pathological fractures occur most often in infants and the young. The skull, ribs, costochondral junctions, and long bones are mainly affected by the disease. Fractures occur, as a rule, in the thigh, leg, and upper extremity. The diagnosis is made physically and by the X-ray. In the latter, subperiosteal hæmorrhages with proliferation or periosteal elevation is generally observed. As treatment is continued, the porosity of bone decreases and new layers of periosteum are noted.

The prognosis is very good. Treatment other than proper splinting consists of supplying vitamin C which is found in oranges, lemons, apples, and bananas. As the majority of fractures occur in infants or the very young, practically speaking, the treatment consists of the administration of orange juice in adequate quantities.

Metabolic disturbances—Diabetes. Pathological fractures occur among diabetic patients very rarely. It is questionable whether the fracture is a result of the metabolic disease or to associated disuse and atrophy.

Metabolic disturbances—hyperparathyroidism. Hyperplasia and also adenomatous changes of the parathyroid glands cause generalized osteoporosis. Pathological fractures may result.

Compere has recently analyzed 12 cases of hyperparathyroidism including one of his own. Five (42 per cent) of these developed fractures. Three (33⅓ per cent) had had multiple fractures when reported. A recent personal case has had multiple fractures (Fig. 19). On three occasions a parathyroid adenoma was removed, and the result was pronounced improvement each time as regards health and hypercalcæmia. It is interesting to note that this patient has had many dozens of fractures and has lost exactly 3 feet in stature. Fifty eight per cent of Compere's collected cases were females. The average age was 37 years, the youngest being 7 and 14 years old, and the oldest 59 years of age. The majority of them had been diagnosed as osteitis fibrosa. Eight of Compere's collected cases had an adenoma of the parathyroid gland. Another was not operated upon, but had bilateral palpable tumors (Duken's Case 2). The cases of Boyd, Milgram, and Stearns had cystic adenomata. Wilder's cases had undergone malignant degeneration. The personal case proved to have a cystic adenoma of a parathyroid. The blood calcium is increased and chemical studies of the urine and fæces show an excessive output of calcium. In addition to extreme generalized osteoporosis, hypotonicity of muscles and cystic degeneration of bones occur. Deformities are common.

The prognosis in the past has been hopeless, but recent operative interference has results in marked improvement. Without operation (parathyroidectomy) the fractures unite slowly and tend to recur.

In addition to immobilization and extirpation of the diseased parathyroid glands, the treatment should be directed toward better calcium deposition. Before operation and after operation the absorption of calcium and phosphorus may be materially benefited by the administration of irradiated ergosterol or codliver oil, heliotherapy, and diet. Future study and literature regarding this interesting subject will eventually clarify the situation.

Fragility due to hereditary disease. Osteogenesis imperfecta (Fig. 20). Osteogenesis imperfecta is claimed to be an inherited diathesis of bone fragility, as many as 9 individuals being affected in four generations. Multiple fractures occur, more often in early life, almost exclusively before the thirtieth year.

Its etiology is little known and its terms are many. The various names confusing this condition are idiopathic osteopsathyrosis, fragilitas ossium, idiopathic fragilitas ossium, brittle bones with blue sclera, brittle bones, congenital rickets, juvenile osteomalacia, osteogenesis imperfecta congenita, osteogenesis imperfecta retarda, osteogenesis imperfecta, hereditary mesenchymic hypoplasia.

Patients suffering with this disease frequently have fractures from trivial traumata or muscular action. Cases are on record where fractures have occurred *in utero* and during passage through the birth canal. The latter should be remembered because of the medicolegal aspects. Usually, though, multiple fractures take place after birth. The X-ray reveals (except in the postadolescent age) extreme bone porosity and frequently many photographs have to be taken to secure a fair roentgenogram of the pathology. These patients frequently have blue scleræ. The long bones of the extremities and the ribs are mainly affected.

In the pre-adolescent stage, the fracture lines have a peculiar appearance and they seem to result from a crumpling or bending action, with frequently an attempt to telescope on one surface. This peculiarity is probably due to the fact that the bone is so decalcified as to be actually softened. The bowstring action of the powerful flexor and extensor muscles or torsion is then sufficient to crumple the softened bones. Despite the low calcium content of the bone, fractures heal quickly and with abundant callus. The blood calcium and phosphorus are usually normal or above normal as in hyperparathyroidism.

The immediate prognosis is good, but recurrent fractures and premature death often result.

We have had occasion to observe or treat some 8 cases of this condition. In one instance multiple fractures occurred in twins 13 months old. In one family under observation, the condition has been present for four generations—a later report will follow.

Osteosclerosis generalisata. Osteosclerosis generalisata has been described by several writers. In this condition, all the bones seem to be abnormally hard or sclerotic. It is spoken of as marble bones. The bones are overcalcified (in comparison to osteogenesis imperfecta) and are entirely lacking in elasticity. The fracture line is often very straight (transverse) or steplike and resembles the breaking of limestone or marble. This condition occurs most often in the young. The etiology is not known, but it has been considered to be the result of a hypervitaminosis. The X-ray picture is pathognomonic, as the bones are revealed to be extremely opaque.

The immediate prognosis is good. No difficulties are encountered as a rule regarding union, though it may be slightly delayed. The ultimate prognosis is guarded because recurrences are the rule. The tendency to fracture usually disappears after the age of 30 years (Babcock). Merrill has recently reported a case.

Gaucher's splenomegaly. In splenomegaly, due to Gaucher's disease (at least), rarefaction of bone takes place. Practically all cases which have recently been subjected to X-ray examinations have shown bone changes. The osteoporosis may be so great as to result in pathological fracture. The lower ends of the femur seem to be oftenest involved.

Welt *et al.* have recently reported 6 cases of this disease, 50 per cent of which developed pathological fractures. The patients complain of pains in the bones, stiffness, and limp. The long bones of the lower and upper extremity are chiefly affected. In addition to the splenomegaly, the symptoms may resemble osteomyelitis and be operated upon for the same as was the experience of Moschcowitz. The diagnosis is made by the blood findings, biopsy, puncture, and X-ray examination (Fig. 21).

TABLE IV.—PATHOLOGICAL FRACTURES

	Pathological condition	Excessive	Normal	Union Delayed	Non	Little Known
1	Cysts		x			
2	Enchondroma		x			
3	Osteitis fibrosa cystica		x	x		
4	Myeloma (benign, single)		x	x		
5	Carcinoma		x	x	x	
6	Sarcoma			x	x	
7	Endothelioma				x	x
8	Hypernephroma*				x	x
9	Myelomata (malignant)		x	x		
10	Acute osteomyelitis	x	x	x		
11	Chronic osteomyelitis	x	x	x		
12	Local pressure		x	x		
13	Neuropathic					
14	Syringomyelia		x	x		
15	Spina bifida		x	x		
16	Hemiplegia		x	x		
17	Infantile paralysis		x	x		
18	Senility		x	x		
19	Disuse (porosis)		x	x		
20	Osteomalacia		x	x		
21	Starvation		x	x		
22	Rickets	x	x			
23	Scurvy	x	x			
24	Diabetes		x	x		
25	Hyperparathyroidism	x	x	x		
26	Osteogenesis imperfecta	x	x			
27	Marble bones		x	x		
28	Gaucher's disease		x	x		
29	Phosphorus		x	x		
30	Radioactive		x	x		
	Totals	6	26	22	4	2
	Percentage	20	89.6	75.5	13.7	6.8
		A	B	C	D	E

*Scudder states that union has been known to occur in hypernephroma.

The prognosis is not good. Splenectomy has aided a number of cases in relieving the anæmia, hæmorrhagic diathesis, and burdensome weight of the organ, but it remains to be determined how curative the procedure is.

Fragility due to chemical irritation in industry. The absorption of certain chemicals in the body may lead to bony deposits of the metal and thence to necrosis. So called "fragilitas ossium" among match dippers has been reported by Dearden. According to him, the bones of such workers contain an excess of phosphoric acid which combines with the pre-existing neutral phosphate to form a slightly acid salt and thereby cause excessive brittleness of the bones, i.e., phossy jaw.

Pearl workers' disease is (Da Costa) due to an osteitis from chemical irritation. Tillmans claims that arsenic and pyrogallic acid produce a similar ossifying periosteitis. Pathological fracture due to the destruction of bone by mesothorium has been recorded by Martland. The fracture sustained was of the upper femur in a girl who painted watch dials with luminescent paint.

The treatment consists of eliminating the causative chemical when possible. The prognosis is

generally good as to union, but poor as to complication.

ANALYSIS OF UNION IN PATHOLOGICAL FRACTURES

Non-union of various grades to excessive union may occur in different types of pathological fracture or in the same disease.

The vast majority of pathological fractures unite. Table IV shows that union may occur in 8[illegible] per cent of the different diseases and 20 per cent may have excessive callus production.

Delayed union (but union nevertheless) may take place in 70 per cent. In only 16 per cent is non-union the rule, though Bloodgood is aware of its occurrence in sarcoma, hypernephroma, and endothelioma. Ten per cent of this latter group are placed in the little known class as insufficient data on reported cases make this necessary. The pseudo fractures described by Milkman[1] probably should be included in the above.

SUMMARY

In fractures through benign tumors union is the rule. In cysts the fracture episode usually results in a cure of the cystic condition.

In malignant tumors union often occurs Hawley states that in carcinoma, union is the rule. Bloodgood states that in metastatic carcinoma union rarely takes place. In Pancoast's experience 40 per cent of pathological fractures due to carcinoma unite—with or without irradiation. In sarcoma Bloodgood states that union is almost unheard of, 2 doubtful cases in his report of 22 examples. There has been union in a single case of endothelioma. Pancoast, also Pfahler, report no union in their experiences. The patients usually die in bed of their metastases, the fracture being incidental. Union is known to have occurred in malignant myeloma cases.

Primary bone tumors have an incidence of fracture in 22.7 per cent of cases (Coley and Sharp).

In acute and subacute inflammatory condition union is the general end-result, if the infection has early and adequate surgical treatment. In neglected cases, especially in adults, non-union may occur.

In chronic inflammatory conditions union is the rule with excessive callus formation.

In fractures occurring in general disease, union is delayed or absent depending upon the course of the general disease. In rickets, osteomalacia and scurvy, proper treatment results in union—osteomalacia frequently heals with excessive provisional callus.

Eighty-nine per cent of causative conditions are known to have union occur, in most of which union is the rule.

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[1]Milkman, L. A. Pseudo fracture. Am. J. Roentgenol., 1930, xxiv, 29.

FRACTURES OF THE PELVIS

A Summary of Treatment and Results Attained in One Hundred and Eighty-Five Cases

LLOYD NOLAND, M.D., F.A.C.S., Fairfield, Alabama
Chief Surgeon, Tennessee Coal, Iron and Railroad Company
H. EARLE CONWELL, M.D., F.A.C.S., Fairfield, Alabama
Orthopedist, Employees' Hospital

THREE years ago we reported before the Surgical Section of the American Medical Association a series of 125 fractures of the pelvis, these cases having been treated by us during the period from January 1, 1920, to July 1, 1928.

We now present for your consideration this series together with an additional 60 cases encountered and treated between July 1, 1928, and July 1, 1931, this constituting a total of 185 consecutive cases treated in an 11 year period.

TABLE I.—ANATOMICAL DISTRIBUTION

	Left	Right
Ala of ilium	25	12
Superior ramus of pubis	36	24
Inferior ramus of pubis	65	27
Superior ramus of ischium	4	2
Inferior ramus of ischium	21	21
Acetabulum	19	18
Separation of symphysis		12
Definite sacro-iliac separation		11
Bilateral pelvic fractures		5
Fracture of sacrum with associated fractures of pelvis		10
Fracture of lumbar vertebra with associated fractures of pelvis		12
Isolated fractures of the tuberosity of ischium		1
Double vertical fracture of pelvis (Malgaigne)		6

It will be seen from Table I that very few of the fractures in this series of cases were single.

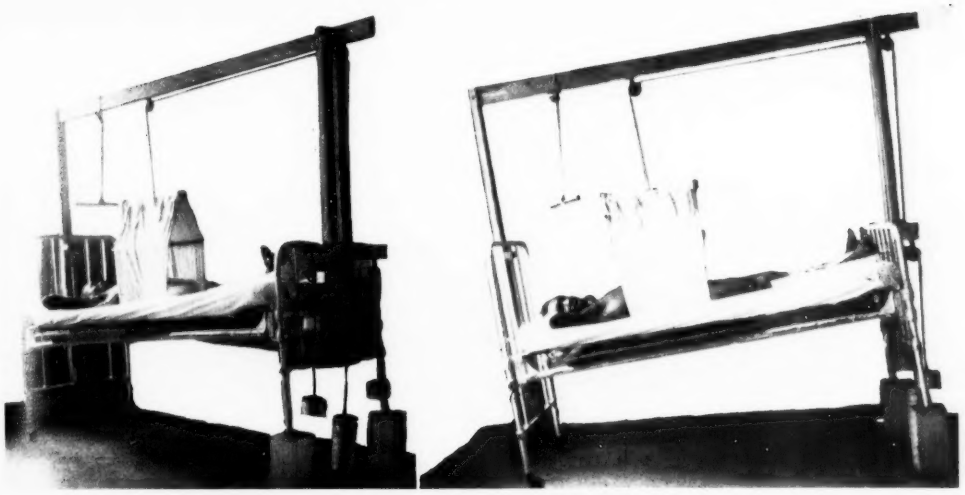
The ages of patients ranged from 2 to 82 years, with a general average of 36 years. The average stay in the hospital was 53 days. There were 141 male patients and 44 females. In 99 cases the fractures were the result of industrial accidents and 86 of civilian accidents. Of the latter 75 per cent were the result of automobile and motorcycle accidents. It is interesting to note that fractures of the pelvis in women during the first three years covered by this series, that is, from 1920 to 1923, constituted only 10 per cent of the total civilian accidents and that since 1923 fractures of the pelvis in women amount to almost 50 per cent of the total civilian cases. Over 70 per cent of these fractures of the pelvis in women were received in automobile accidents, and, as far as we are able to judge, such fractures were caused by trauma of definitely less severity than that producing such fractures in men.

It is impossible to divide the severity of the cases in this series with regard to time lost. However, in reviewing the civilian and industrial accidents, we feel that, while the severity of injury in each type of case was about equal, the civilian cases as a class were worse than the industrial accidents. Seventy-five of the civilians returned to their former duty, and the remainder are earning a livelihood at some gainful occupation. The number of days lost from work averaged 140, the industrial accidents losing an average of 154 days and the civilian accidents returning to work in an average of 130 days; this difference in lost time we attribute largely to the provisions of the Compensation Law.

Sixty-four of the industrial accidents were complicated with other fractures or severe injury of the soft structures. The uncomplicated cases and 24 of the complicated cases returned to full duty without any permanent disability, while the remaining cases had disability ranging from 15 per cent to total disability. In no case was the pelvic fracture the only cause of disability as there were severe associated injuries in every instance. However, most of the disabled patients are earning a livelihood today at some lighter occupation.

Complications in these cases, listed in their order of frequency, were as follows: blood in urine; extraperitoneal hæmatomata; extraperitoneal rupture of the bladder; rupture of the deep urethra; intraperitoneal rupture of the bladder; laceration of the perineum; contusion and rupture of the kidney; injury to the rectum; fracture of the femur; dislocation of the hip; fracture of the spine; miscellaneous fractures. In 78 of the total 185 cases blood was found in the urine; of these, 26 patients had sustained rupture of the bladder, 8 intraperitoneal and 18 extraperitoneal. Eleven patients had either severe laceration or complete division of the deep urethra. In several of the severe cases the apparent tendency to the formation of renal and vesical calculi was very marked during the convalescent period.

There was a total of 30 deaths (16.2 per cent) in the 185 cases. Nineteen of these patients died within 24 hours following admission, all of whom had severe associated injuries which were regarded



Suspension and traction applied in case of fracture of the pelvis.

as necessarily fatal, and the most of them were practically moribund on admission to hospital. The remaining 11 patients died as follows: 3 within 48 hours; 3 within 72 hours; 2 within 3 days; 1 within 4 days; 1 within 32 days; 1 within 4 months. The causes of these deaths varied as follows: shock; pneumonia; rupture of intestines; intra-abdominal hæmorrhage; pulmonary embolism; intrapelvic and intra-abdominal hæmorrhage; rupture of rectum; rupture of the bladder and urethra; multiple fractures of the pelvis and spine; and general septicæmia.

Since the publication of the previous series we have had a number of inquiries from obstetricians as to the effect on normal delivery of various fractures of the pelvis. It so happens that in our series we have observed very few pregnancies subsequent to injury. In one case it was necessary to perform a cæsarean section because of impairment of the pelvic outlet. Therapeutic abortion was performed on two patients, one of whom became pregnant 2½ months and one 3½ months after injury. One patient whom we regarded as having only fair results has borne two children since injury. The first delivery, which occurred about 2 years after injury, was of the breech type; the second delivery, 1½ years later, was accomplished by version and extraction. The patient stood both deliveries in a most excellent way. We believe that if pregnancy occurs within 5 months following a severe fracture of the pelvis, therapeutic abortion is indicated. Pregnancies occurring at later dates should be handled as indicated by the condition of the pelvic ring. In certain cases cæsarean section will be indicated; in many others we feel that normal delivery can be accomplished.

Only about 55 per cent of the total series of patients had what we regard as good anatomical position when discharged, but we are sure, from our observation, that excellent functional results are frequent in cases in which good anatomical position is by no means secured. Open reduction for correction of displacement of bony fragments was done in only 2 cases, and then only to relieve pressure of the displaced fragment on the rectum and bladder. It is our opinion that what appears to be a poor position of the fragments is by no means a constant cause for persistent pain and disability. We have frequently observed that in cases in which there was marked displacement of fragments there was less pain and less disability than in others in which excellent position was secured. This at times is difficult to explain.

We are still of the opinion that a standardized method of treatment, by use of the overhead pelvic suspension frame with traction on the lower extremities, presented in our previous paper, will yield excellent results in a higher proportion of cases than any other method.

On admission to hospital complete X-ray examination is made of every patient, and in cases of severe shock this is done by the use of a portable machine at the bedside. Careful and painstaking physical examination is then made to determine as quickly as possible the extent of soft part

injuries. If gross blood is reported in the urine, an immediate attempt is made to determine the source, whether from urethra, bladder, or kidney. This, of course, calls for considerable judgment and is not always easy, as great harm may be done by injudicious instrumentation.

If intraperitoneal rupture of the bladder or other intra-abdominal visceral lesion is suspected, laparotomy is performed as soon as the condition of the patient will allow. If extraperitoneal rupture of the bladder is suspected, great care is taken in operating to prevent entrance into the peritoneal cavity. If the lesion is in a position to allow of suture, immediate closure is done; if not, very careful drainage both by incision and by catheter is practiced. In cases showing gross lesion of the posterior urethra immediate perineal urethrotomy is performed and whenever possible the urethral lesion is sutured. Drainage should be practiced in every case of gross injury to the bladder with extravasation, but we are definitely of the opinion that hæmatomata without urinary extravasation should not be drained unless secondary infection should occur. It is unnecessary to say that the treatment of these vesical and urethral injuries should include careful observation for weeks or months after the original injury.

Following careful examination and treatment of complications, the patient is placed in bed and treatment of the fracture begun with an overhead pelvic suspension frame, suspension being obtained by a canvas sling or hammock which extends from the upper third of the thighs to the lower dorsal region. This hammock acts as an immobilizing factor because of the lateral compression action on the pelvic girdle, the force being approximately equal to the body weight. This force is continually in action, and, as relaxation of the muscles takes place, there is a constant tendency for the displaced fragments to fall into their natural position. Generally marked relief of pain is noticeable within the first few hours following the application of the pelvic hammock.

Suspension is supplemented in every case by traction on the legs and thighs, with about 15 to 20 degrees of abduction of the thighs at the hips. Abduction relieves the marked spasm of the strong adductors of the thighs and pelvis, prevents scissoring of the thighs, tends to pull the fragments back into place, and prevents the limited abduction that is so commonly observed following these injuries.

The amount of weight on the hammock suspension is regulated by the weight of the body area which the hammock supports. It is our aim to use sufficient weight almost to counterbalance the weight of the patient, but not enough to raise the patient completely from the bed. Weights used for leg traction vary from 4 to 8 pounds, depending on the size of the patient and the type of the fracture. Cases in which there is involvement of the posterior ring or sacro-iliac dislocation require more weight. It may be necessary to apply more weight on one side than the other, depending on the presence of overriding.

Leg traction is used in all types of fracture of the pelvis except in those showing an isolated fracture of the anterior-superior or anterior inferior spines of the crest of the ilium. In these cases only the hammock suspension is used, supplemented by flexion of the knees obtained by the use of pillows. Flexion in these cases should be about a 20 to 30 degree angle at the hips.

A spreader is used in certain cases to prevent too great a lateral pressure. Lateral pressure of the hammock may at times cause an overlapping at the points of fracture unless it is offset by the intelligent use of the spreader. The degree of lateral pressure can easily be governed by the raising or lowering of the wood spreader. The spreader should be the exact width of the individual's pelvis, within the canvas sling. The use of the spreader should be routine treatment except in cases in which a separation of the symphysis is present. In such cases a high degree of lateral pressure is necessary and is obtained by the use of the hammock without the spreader.

The method of treatment described gives a high degree of ease and comfort to the patient, greatly simplifies nursing care, prevents a certain amount of muscular atrophy, allows for improved circulation throughout the pelvis, and provides easy access for care and dressings when the soft parts have been injured. In the simple uncomplicated cases it is rarely necessary to administer an anæsthetic in application of the overhead pelvic frame and traction.

We believe that these fractures should be treated by traction and suspension for an average period of at least 42 days. At the end of this time the hammock is removed and the patient is allowed to move about in bed for another week. A pelvic belt is applied immediately after the removal of the hammock. At the end of the seventh or eighth week the patient is allowed out of bed and begins weight bearing with the aid of crutches.

Gradual increase of weight bearing is determined by the amount of callus formation as shown by X-rays and by the comfort of the patient as weight bearing is increased. In certain cases callus formation has definitely been hastened in-

ct ased weight bearing is allowed; but this meth-
o s resorted to only in carefully selected cases.
s convalescence proceeds, daily hot tub baths
a local heat are used. Patients are kept under
cl e observation at the orthopedic out clinic until
fu return to duty is permitted. We feel that a
m t important point in the securing of results is
th keeping of these patients under close observa-
tio for a long period.
udgment should be used in forcing these men
ba to work. In our early experience we were
in ined to return them to work as early as possi-
ble but we frequently found that after a few days
at work they were inclined to develop muscular spasm of the back and thighs, which necessitated return to bed with consequent lowering of morale. We attempt at all times to assure the patient that he has excellent prospects of recovery, and that the long period of treatment in bed is not because of the expectation of a permanent disability, but to enable the fractures to be immobilized long enough for union to take place.

We consider that close co-operation between the general surgeon and the orthopedist is necessary in order to secure the best results in these cases, the general surgeon handling complications of the soft parts and the orthopedist that part of the work falling under his jurisdiction.

POSTERIOR MARGINAL FRACTURE OF THE TIBIA

FRANK D. DICKSON, M.D., Kansas City, Missouri

FROM the year 1768, when Percival Pott gave to medical literature his classical description of that fracture of the ankle which still bears his name, down to the present day, fractures of this region have continued to be a surgical problem of ever increasing interest. It is this fact that has given me courage to contribute some observations on the management of one of these fractures, the so called posterior marginal fracture of the lower articular surface of the tibia. If additional incentive were needed it is the conviction that, notwithstanding the wealth of literature available on the treatment of fractures of the ankle, the results generally obtained fall far short of what they should be; this is particularly true of posterior marginal fractures. Testimony to this is borne by the number of poor late results seen when any considerable number of fractures of the ankle are checked up after the lapse of several years. Of the 15 posterior marginal fractures in this series, 5, or 33⅓ per cent, were old fractures with malposition and disability.

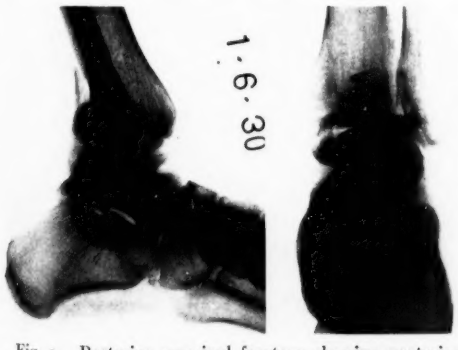


Fig. 1. Posterior marginal fracture showing posterior and lateral displacement of the foot.

Posterior marginal fractures comprise about 19 per cent of all fractures of the ankle joint according to Ashhurst and 10 per cent according to Speed and other writers. In a series of 93 fractures involving the ankle joint seen in our clinic 15 or 16.1 per cent were posterior marginal fractures. The lesion (Fig. 1) is one in which we have a fracture of the internal malleolus with the fracture line extending across the posterior surface of the tibia in such a way as to split off a part or the whole of the posterior margin of the lower articular surface of the tibia, and a fracture of the lower end of the fibula, usually low down. The deformity which results is a lateral displacement of the foot and a posterior dislocation of the ankle. Such an injury is in reality a bimalleolar fracture complicated by the splitting off of the posterior part of the lower articular surface of the tibia. It should be mentioned that a posterior marginal fracture may occur without displacement of the ankle (Fig. 2).

The suspicion that a bimalleolar fracture is complicated by a posterior marginal fracture should be aroused by two signs which Cotton has emphasized: (1) prominence of the anterior margin of the tibia which, however, is less as a rule than in complete dislocation of the ankle; (2) the marked instability of the ankle and consequent tendency for deformity to recur after reduction. A properly made roentgenogram

Fig. 2, left. Posterior marginal fracture without posterior displacement of the foot.
Fig. 3. The result obtained in case shown in Figure 1.

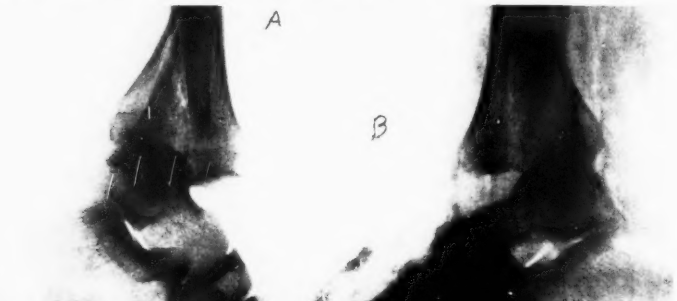


Fig. 4. Posterior marginal fracture. A, Original injury. B, Failure to retain position after reduction and the application of a cast.

should clear up any doubt as to the character of the injury and lead to properly planned treatment. Apparently, however, in a surprising number of cases although the bimalleolar fracture is recognized and the deformity corrected, the posterior marginal fracture is overlooked or the importance of completely reducing the posterior displacement of the ankle and accurately restoring the contour of the lower articular surface of the tibia is not appreciated. If this is not done after the fracture heals limitation of ankle flexion and extension remains, a painful ankle results which very definitely interferes with function and a permanent disability is established. In this fracture as in all ankle fractures accurate reduction is essential to a satisfactory functional result; clinical evidence all points toward the conclusion that given a good anatomical reduction the functional result is rarely unsatisfactory.

TREATMENT

We have separated the cases of posterior marginal fracture seen in our clinic into three groups:

1. Fractures seen immediately following or within a few hours of the injury.

2. Fractures seen after a lapse of several days up to several weeks without reduction.

3. Fractures seen after several months or years with malposition.

The fractures seen shortly after the reception of the injury will, as a rule, present no particular difficulty in reduction if a correct diagnosis has been made (Fig. 3). Under the general or local anæsthesia, the knee should be flexed, to relax the tendo achillis, and the posterior part of the foot strongly adducted and inverted with the ankle in moderate equinus. Since the astragalus and the marginal fragment are attached to the fibula and, in fracture of the ankle, displaced with

Fig. 5. Posterior marginal fracture reduced by operation and beef bone screw used to hold fragments in place 4 months after reduction.

Fig. 8. Old posterior marginal fracture showing characteristic deformity in unreduced case. There is marked impingement of the posterior surface of the tibia against the superior surface of the astragalus.

it, it seems logical that the primary step in reduction should be the correction of the fibular displacement. When sufficient adduction and inversion have been secured to correct the lateral displacement the foot should be pulled forward and brought into complete dorsal flexion. Dorsal flexion should make the posterior ligament, which is seldom torn, tense and so tend to mold the displaced fragment back into place and hold it there. A plaster cast is immediately applied and for two weeks is allowed to extend above the knee which is held in moderate flexion. Any tension on the tendo achillis should, we believe, be avoided for this length of time as it may cause a recurrence of the posterior dislocation and displacement of the marginal fragment. After 10 days to 2 weeks the cast is cut down below the knee and the usual after-treatment of fractures of the ankle followed. Weight bearing is not permitted under 8 weeks. The instability of the ankle in posterior marginal fractures should be constantly borne in mind and a checkup roentgenogram made immediately after the application of the cast. We are accustomed to check the position at least once or twice more during the first 10 days or 2 weeks following reduction.

From time to time we have had referred to us cases in which the posterior displacement has not been recognized or in which attempts to secure satisfactory reduction have been unsuccessful and the displacement has existed from several days to several weeks (Fig. 4). In such cases the problem of reduction is somewhat different from that in acute fractures; it is often difficult or

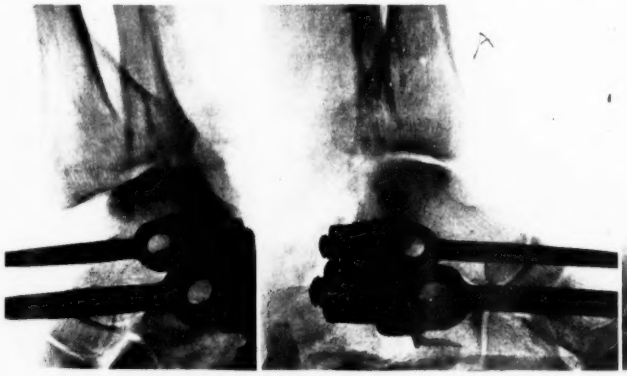


Fig. 6.

Fig. 6. Posterior marginal fracture with recurrent posterior displacement after reduction showing Kirschner wire through the astragalus.

Fig. 7A.

Fig. 7B.

Fig. 7. A, Correction of posterior displacement shown in Figure 6 by skeletal traction. B, Final result in this patient.

impossible to influence the position of the displaced tibial fragment and maintain the anterior position of the foot. The difficulty in reducing the fragment is probably due to organizing procallus filling up of the space between the tibia and the fragment and to adhesions which have formed between the displaced fragment or fragments and the surrounding soft parts. In these older cases, if satisfactory reduction cannot be secured by manipulation, reduction by operation must be resorted to or some form of non-operative management employed which will successfully overcome the displacement. We have operated upon several cases in our clinic; in some we have simply reduced the posterior displacement and put the marginal fragment in relation with the tibia. In others in which the fragment was large and the ankle seemed unstable following reduction, we have held the fragment in place with a beef bone screw (Fig. 5). The results have been satisfactory if not perfect in all cases operated upon.

We have also used a non-operative type of treatment in these resistant cases which, although not sufficiently tested to allow positive conclusions to be drawn, yet seems worthwhile describing. In this non-operative procedure the leg is encased in a plaster cast from above the knee to the ends of the toes, the cast being heavily padded about the lower end of the tibia. The front of the cast is then removed from the ends of the toes to the level of the lower end of the tibia only a posterior shell being left. A Kirschner wire is then passed through the astragalus and, using an overhead pulley, direct traction is made upward, or in reality forward, on the foot (Fig. 6). Counter-traction is supplied by the presence of the cast against the lower end of the tibia. Such traction is allowed to remain 3 weeks. In 3 cases in which this method has been used it was found quite efficient (Fig. 7). It would seem that this method might be applicable in fresh fractures in which there is a tendency toward displacement after reduction as shown in the roentgenogram. In describing this method of direct skeletal traction, no claim of originality is made as it has probably been used by others in reducing this displacement but has not come to our attention.

In the old fractures with malunion we have, even if posterior displacement has been largely corrected, a filling in of the space between the tibia and the displaced fragment with callus which produces a deepening of the lower articular surface of the tibia from before back (Fig. 8). The combination of even slight posterior displacement of the astragalus and deepening of the lower tibial articular surface results in impingement of the lower end of the tibia against the posterior superior surface of the astragalus limitation of flexion and extension of the ankle and a painful joint. In dealing with this situation a reconstruction type of operation is necessary and the results in our experience, while satisfactory so far as improvement of function is concerned, still leave much to be desired. Two types of operation have been used in our clinic. In one case, through two lateral incisions an osteotomy of the fibula was performed and the resisting structures around the internal and external malleoli were loosened until the astragalus could be displaced forward. The projecting posterior margin of the tibia was then resected until it ceased to impinge on the superior surface of the astragalus. The result was improved function to a satisfactory extent but still with much disability. In 2 cases the resisting structures were loosened up and the astragalus brought forward as in the preceding case but instead of resecting the posterior margin of the articular surface, a wedge of bone was removed corresponding to the excess callus, so far as we could estimate it, and the normal contour of the lower tibial articular surface restored approximately. The results in these 2 cases were better than in the first case, in our opinion, probably due to the fact that a more normal reconstruction of the lower articular surface of the tibia was secured. In a certain proportion of old cases with extreme deformity arthrodesis of the ankle should be the operation of choice.

CONCLUSIONS

From our experience with posterior marginal fractures, we draw the following conclusions:

1. Posterior marginal fractures of the ankle, if not properly reduced, carry the certainty of resulting in marked disability.

2. Immediate reduction of both the lateral and posterior displacement should be carried out and the result checked by roentgenograms every few days for at least 10 days.

3. If adequate reduction cannot be secured by manipulation direct skeletal traction or reduction by operation must be resorted to.

4. Malposition in posterior marginal fractures may be improved by some form of reconstruction operation but impairment of function will remain.

5. If there is any question of the success a reconstruction type of operation arthrodesis of the ankle should be performed.

COMPOUND FRACTURES OF THE LONG BONES

Review of Three Hundred and Four Cases Treated by Débridement, Carrel-Dakin Technique, Open Reduction and Plating When Indicated[1]

GEORGE V. FOSTER, M.D., F.A.C.S., Pittsburgh, Pennsylvania
From the Clinic of W. O'Neill Sherman, M.D., F.A.C.S.

During the past 15 years in this Clinic, certain definite surgical principles have been routinely adhered to in the treatment of compound fractures and this paper comprises a review of the results of 304 compound fractures of the long bones. These formed part of 7,069 fractures received by employees of the Carnegie Steel Company from 1917 to 1932, and of this number 2,440, 34 per cent, were compound fractures. This high percentage of compound fractures is indicative of the severe crushing type of trauma causing the injury. The 304 cases reviewed here comprise the compound long bone fractures, which came under our care during this period.

These fractures were almost entirely sustained by direct violence and most of them showed extensive mutilation of the soft tissues. They were mainly in men employed in mines, steel mills, or railways, injured by falls of slate, crushed by falling piles of steel, or traumatized by coming in forcible contact with moving freight cars.

The majority of these fractures came into the hands of some member of this Clinic within 10 hours of the time the fracture was sustained; about 5 per cent were treated in other hospitals, following the principles outlined here and transferred under our care as soon as they had recovered from their shock.

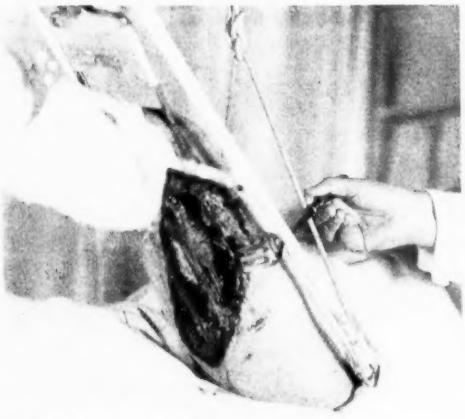


Fig. 1. Case 3, J. P. Showing compound wound of femur on admission.

The following principles are followed on all compound fractures, regardless of their severity:

1. The wound associated with a compound fracture is looked upon as just as stirring an emergency as an acute abdominal condition, and at least débridement is carried out with as short a lapse of time as possible. The limb is shaved, the skin cleansed with soap, ether, and alcohol; the crushed lifeless flesh is conservatively excised and the wound flushed out with Dakin's solution. Vaseline gauze protects the wound margins.

2. Carrel tubes are put in place in the wound and over the wound immediately following the débridement, the limb is elevated, and Dakin's solution is used to irrigate the wound sufficiently often to keep it saturated. Usually 2 drams of the solution in each tube are required every 2 hours. The dressing is changed every second day.

3. At the time of operation when the X-ray plates are seen and also the wound itself with its associated bone injury, a decision is reached as to the best and safest line of treatment to follow in an effort to obtain as good a reduction of the fracture as possible. Reduction may entail the curetting of the bone ends and approximation of the fragments with immediate application of a Sherman steel plate or screws, the application of skeletal traction, Kirschner wires, adhesive traction with a proper splint, or simply support with molded plaster coaptation splints. The treatment decided upon is carried out at the same time as the débridement is done.

4. The wound is left open. It may happen that to apply internal fixation the wound may have to be enlarged and then it is permissible to close the wound for a short distance, but any attempt at complete closure is disastrous and unnecessary. In almost all cases the wound will have closed before the bone is sufficiently strong to bear weight and the unfortunate sequence of cellulitis, osteomyelitis, and possibly amputation should be sufficient to deter one from closing a compound fracture when nothing is gained by so doing.

5. The plate or screw, if such is applied, is removed as soon as union has taken place in the bone unless the wound has already healed over it.

[1] Presented before the Society of Examining Physicians, Boston, April 27, 1932.

Fig. 2. Fig. 3. Fig. 4. Fig. 5.

Fig. 2. Case 3, J. P. Anteroposterior view of compound fracture on admission.
Fig. 3. Case 3, J. P. Lateral view of fractured femur on admission, showing fracture extending down to knee joint.
Fig. 4. Case 3, J. P. Showing anteroposterior view of femur 4½ months after admission.
Fig. 5. Case 3, J. P. Showing lateral view of femur 4½ months after admission.

We cannot stress too emphatically the necessity for an immediate adequate débridement and early institution of Carrel-Dakin technique to these wounds. The débridement should consist of removal of all foreign bodies, blood clot, tissues thickly impregnated with dirt and dead or dying muscle, fascia, skin, or periosteum, the removal by sharp dissection of the wound edge until a healthy bleeding surface is obtained, the exploration, cleansing, and free drainage of all cavities. To excise satisfactorily the mutilated tissue in an extensive crushing wound requires a general anæsthetic and considerable patience should be exercised to make sure of leaving the wound absolutely clean. A delayed débridement or one done hurriedly, may lead to infection.

Fig. 6. Case 3, J. P. Showing compound wound after skin grafting. Thiersch grafts used.

These compound fractures are divided into three classes depending upon the size of the resulting wound and the position of the bone fragments (16, 17). Appropriate, well defined treatment is begun within a few minutes of the time of injury by a capable surgeon located at each individual plant. The area around the wound is shaved, cleansed with ether and alcohol, a Dakin dressing is applied, and a well fitting splint put in place in an excellent manner, and the man is then sent to one of the central hospitals with as short a lapse of time as possible. The man is kept in the hospital until almost complete function has returned so that he may be under our control and guidance and receive the advantages of our physiotherapy department. On discharge from the hospital, in most cases he is able to return to light work immediately.

In describing the methods used in the treatment of these three divisions of compound fracture 5 case reports are included at the end of each division. These were the 5 last cases of each group under our care at Western Pennsylvania Hospital before this data was compiled.

A. In extensive compound, comminuted fractures in which it is impossible to aline the fragments satisfactorily and hold them with a steel plate, the wound is cleaned and thoroughly

e ised as described and skeletal traction, tongs, K rschner wire, or other forms of skin or skeletal t ction is applied and the wound is irrigated th roughly with Dakin's solution. In this class a o we shall consider the fractures which, though c mpound, are in good position and require only th application of lateral coaptation splints after th débridement has been done.

ASE 1. J. B., 36 years old, injured March 28, 1930, at 4 P.M., when pile of steel beams fell on left lower leg al ost completely severing the leg. He was treated for sh ck, a splint was applied and the man was sent to ho pital. Examination revealed moderate shock, tremendo s destruction of soft tissue and bone. The tibia and fibula were both badly comminuted. Eight hours after accident the wound was thoroughly cleaned under ethylene anæsthesia and fragments of bone were put in place between the ends of the tibia. Lateral splints were applied and Carrel-Dakin treatment instituted. On April 17, 1930, it was seen that the comminuted fragments were so small that they would not unite to main fragments and they were removed. The original length of leg was preserved by insertion of Kirschner wires through os calcis and applying traction. On May 23, 1930, wires were removed from os calcis. On June 17, 1930, sequestrectomy of tibia was done. On August 25, 1930, entire healing of soft parts had taken place but there was a 1½-inch separation of fragments of tibia. There had been so much soft tissue destruction that it was felt that more healthy tissue would be necessary over the tibial crest to nourish the bone graft which would have to be put in place. Therefore between September 30, 1930, and October 28, 1930, a large pedicle skin flap was transferred from the right leg to replace the thin scar over the left tibial crest. The man was allowed up on crutches and sent home until time for bone graft. He returned in April, 1931, at which time a sliding bone graft was done with good union resulting. He has good knee motion and fair ankle motion at the present time.

CASE 2. W. G., 30 years old, negro, injured May 7, 1930, at 10:15 p.m. Left leg was crushed between steel beams. Dakin dressing and Thomas splint were applied and he was transferred to the hospital. Examination disclosed a compound, comminuted fracture in upper third of left tibia and fibula, extensive laceration extending over knee joint on outer side of leg; laceration 1 inch in length over inner part of leg. At 1:20 a.m. under spinal anæsthesia, débridement was carried out, Carrel-Dakin technique was instituted and a Steinmann pin was inserted through the os calcis, and a 15 pound weight was attached, with leg in Thomas splint. June 18 wounds were almost healed so chlorazene ointment was applied instead of Dakin solution. Fibrous union was present, lateral splints were applied, and patient was encouraged to bear weight from July 1 to July 10, when he was discharged. Returned for physiotherapy until September 8, 1930, when he was sent to work.

CASE 3. J. P. (see X-ray prints and photographs), 45 years old, Slav, was injured May 15, 1930, at 4:15 a.m. when steel "buggy" ran over left thigh. The wound was cleansed, a sedative given, a splint was applied at mill, and the man was sent to Western Pennsylvania Hospital. Examination revealed considerably shocked but conscious patient. Tissues of left thigh were crushed apart over the lower two-thirds of the thigh, the bone was badly comminuted and displaced. The femoral artery was exposed for 3 inches. At 9 a.m. after treatment for shock, patient's thigh was thoroughly cleansed under spinal anæsthesia, skeletal traction was applied to the lower end of the femur, a Thomas splint was put in place and 20 Carrel tubes were distributed about the wound. On May 26, temperature had risen to 104 degrees, 15 additional Carrel tubes were inserted and through-and-through irrigation was established. Temperature dropped to 100 degrees. Pressure pads were used to press the fragments into position. Good union was present and skeletal traction was removed June 17. Adhesive traction was continued until July 10. The

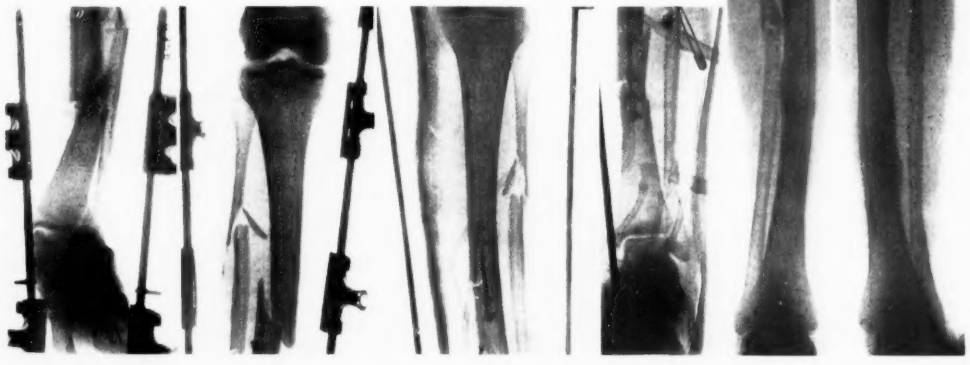


Fig. 7. Fig. 8. Fig. 9. Fig. 10. Fig. 11.

Fig. 7. Case 6, J. Z. Anteroposterior view of left leg on admission. Compound, comminuted fracture of tibia and fibula.

Fig. 8. Case 6, J. Z. Anteroposterior view of right leg on admission. Compound, comminuted fracture of tibia and fibula.

Fig. 9. Case 6, J. Z. Right tibia and fibula. Primary plating done a few hours after the accident.

Fig. 10. Case 6, J. Z. Left tibia and fibula. Primary plating done a few hours after the injury.

Fig. 11. Case 6, J. Z. Showing both bones of both legs, firmly united and with plates removed.

Fig. 12. Fig. 13. Fig. 14. Fig. 15.

Fig. 12. Case 9, M. K. Lateral view of compound, comminuted fracture of tibia before reduction.

Fig. 13. Case 9, M. K. Anteroposterior view of fractured tibia and fibula—before reduction.

Fig. 14. Case 9, M. K. Lateral view after primary plating, done 10 days after injury.

Fig. 15. Case 9, M. K. Anteroposterior view after primary plating.

large raw area was microscopically clean on July 22 and 5 large Thiersch grafts were put in place. The skin was entirely healed by August 5. Treatment was begun with Morton Smart machine. Man was discharged on December 4, 1930, with instructions to return to work immediately. One inch shortening had been compensated by lift on shoe. There was 60 degrees motion in knee.

CASE 4. J. T., aged 27 years, steel worker. At 9:30 a.m. on January 24, 1931, a steel "buggy" ran over his right foot and leg. The skin was shaved, cleansed with ether, Dakin's compress was applied, a Cabot splint was put in place at the mill hospital, and the man was sent to Western Pennsylvania Hospital. Examination showed a compound fracture of the right fibula with laceration 2 inches in length just above the ankle joint. There was a simple fracture of the first and second cuneiform bones. All fractures were in good position. At 12 noon on January 24 débridement of the leg was done under novocain 1 per cent, plaster coaptation splints were applied, and the leg was elevated in Cabot splint. On February 13, the wound was completely healed and physiotherapy was begun with the Morton Smart machine. February 27 no further disability from fractured fibula was noted but there was considerable discomfort from the fracture of the cuneiform bones until his return to work June 7, 1931.

CASE 5. H. C., aged 36 years; bookkeeper, injured September 1, 1931, at 11 a.m., falling down 10 steps, receiving a compound, comminuted fracture of left tibia and fibula. He was brought to the hospital immediately. Examination showed a large piece of bone protruding from a wound 2½ inches long on the outer lower third of tibia. X-ray films showed comminuted fracture at junction of lower and middle third of left tibia and fibula and simple fracture of internal and external malleoli. Patient was taken to operating room at 3:15 p.m., débridement of the wound under spinal anæsthesia, but it was found impossible to reduce the fracture through this wound so an incision was made over the crest of the tibia. The wound was carefully blocked off and tissues and bones handled with non-touch technique. The bone fragments were cleaned with curette and Dakin's solution and jammed between the main fragments, thus preserving the original length of bone. A steel plate could not be applied owing to the comminution present. The operative wound was partially closed while the "compound" wound was left wide open. Carrel-Dakin technique was begun and the leg was encased in lateral plaster splints. On October 10 both wounds were entirely healed. On November 3 treatment with Smart machine was started though only fibrous union was present. Patient could not dorsiflex the foot. On December 1 patient was walking in double leg irons with aid of cane—good union and able to dorsiflex foot slightly. On December 22 he walked quite well with ability to dorsiflex foot 50 per cent and he had full knee motion. He returned to work January 2, 1932. Almost complete return of dorsiflexion of foot present by February 1 and patient working steadily.

B. *Primary plating* (4). When the opening in the skin is at least 1.5 inches long and the fragments are not in position suitable for good union a direct attack is made upon the bone immediately, the ends curetted, and put in good position a Sherman vanadium steel plate applied, the wound left open, and Carrel-Dakin treatment applied. In these cases the screws transfixing the plate to the bone are of such length that they go into the proximal cortex only and, except in rare cases do not go through the medullary canal and transfix

Fig. 16. Fig. 17. Fig. 18.

Fig. 16. Case 10, G. G. Compound Pott's fracture before reduction.

Fig. 17. Case 10, G. G. Anteroposterior view of fracture after immediate reduction and application of a plate.

Fig. 18. Case 10, G. G. Lateral view of fracture after immediate reduction and application of plate.

the other side. When it is necessary to engage a loose fragment on the opposite side of the medullary canal, or when a transfixion screw alone is used to hold the fragments of a compound spiral fracture in place, then it is quite permissible to send the screw through the canal. Lateral molded plaster splints are applied in such a way that the wound may be dressed without disturbing the supporting splints. The edges of the plaster splints about the open wound are protected with oiled silk to prevent the irrigating fluid from destroying the cast. It is rare that Dakin's solution softens a cast sufficiently in the course of treatment that it is necessary to build a second pair of splints. Dakinization is continued until the wound is only a small abrasion, then chlorazene ointment, zinc oxide, or other mild protective is applied until the wound is entirely healed.

Case 6. J. Z., (see roentgenograms), aged 24 years, was injured April 18, 1928, at 11:30 a.m., by falling 35 feet, alighting on a hard surface. Dressings were applied with Cabot splints at mill hospital and the man was sent to Western Pennsylvania Hospital. Examination showed a moderately shocked man with extensive compound fractures of both bones of both legs, simple fracture of both os calcis and dislocation of left ankle. On April 18, at 5:00 p.m., after treatment for shock, both legs were thoroughly cleaned of mutilated tissue under ethylene anæsthesia and four screw Sherman plates were applied to each tibia. The wounds were left open and Carrel-Dakin treatment was instituted. The dislocation of the left ankle was reduced. On June 16, 1928, both plates were removed and the screw holes curetted. On August 20, 1928, firm union was present and patient was walking with double leg irons. On March 21, 1929, both legs were entirely healed and patient was discharged to light work. Patient left work and returned on February 2, 1930, when a pedicle flap was put in place over the crest of the left tibia. It was later necessary to fuse both os calcis-astragaloid joints. There is still some pain present in left os calcis-astragaloid joint.

Case 7. M. B., aged 38 years. On March 11, 1930, at 7:30 a.m., patient's right forearm was caught between a crank arm and beam. The wound was cleaned, splint applied and he was sent to hospital immediately. Examination revealed a compound, comminuted fracture of the right radius with considerable displacement, a simple fracture of the right ulna with angulation. The wound was débrided at 11:35 a.m. under ethylene anæsthesia, the ulnar angulation straightened, and the fractures of the radius placed in good position and held by one screw. Anteroposterior plaster splints were applied and Carrel-Dakin treatment was instituted. On April 29 ,1930, good union was in both bones. The wound healed and Morton Smart treatment was begun. Patient was discharged to light work on May 13, 1930, with full motion present in wrist and elbow.

Case 8. P. P., aged 60 years. May 17, 1930, was struck on the left leg by a flying piece of machinery as the result of an explosion. Two open wounds over the left tibia were cleaned, Cabot splint was applied at the mill hospital and man sent to city hospital. Examination showed compound fractures of the left tibia and fibula at junction of the upper and middle thirds and at the junction of the middle and lower thirds. Each compound wound was about the size of a 50 cent piece. The lower fracture of the tibia was comminuted. Man was in moderate shock. Under ether anæsthesia, 4 hours after the accident, débridement of the wounds was done and a four screw Sherman plate was applied to the upper fragments and two transfixion screws held the lower fragments in excellent position. Lateral plaster splints were applied and Carrel-Dakin technique commenced, with leg elevated in a Cabot

Fig. 19, left. Case 14. B. C. Showing lateral view of compound fracture of tibia before secondary plating was done.

Fig. 20. Case 14, B. C. Secondary plating done 14 days after injury. Two attempts at closed reduction had failed. Plate healed *in situ*.

splint. Man collapsed during the operation and artificial respiration and intravenous adrenalin were resorted to before he revived. On June 19, 1930, plaster splints were changed and the upper plate was removed. On July 5, 1930, screws in lower fracture were removed and screw holes curetted. Good union was present in both fractures. On July 18, 1930, the compound fracture wound was entirely healed and a Delbet splint was applied. Treatment with Morton Smart machine was commenced. On August 12, 1930, a walking Delbet splint was applied. On September 5, 1930, patient was discharged wearing only a single leg iron with firm union in fractures and 80 per cent motion in knee and ankle.

CASE 9. M. K. (see roentgenograms), injured June 16, 1931, at 12:20 p.m., when he fell a distance of 15 feet, receiving a compound, comminuted fracture of the left tibia and fibula. The wound was cleaned with ether, a Dakin's compress was applied and a Thomas splint put in place at the mill hospital, and the man sent to Western Pennsylvania Hospital. Examination disclosed a 27 year old steel worker in slight shock. A fragment of the tibia was sticking through an open wound 2½ inches in length in the lower third of the left leg. At 5:00 p.m., June 16, a débridement was done under spinal anæsthesia. The comminuted fragments were replaced after cleaning with a curette. A six screw Sherman vanadium steel plate was applied, the wound was left open, and the Carrel-Dakin technique was instituted. Lateral plaster splints were applied and the leg was elevated in a Cabot splint. After the second day temperature never rose to one hundred degrees. Carrel-Dakin treatment was continued until the leg was entirely healed on August 26, 1931. Physiotherapy in the form of Morton Smart treatment was begun and by September 15, 1931, firm union had taken place in the tibia. Man was given treatment for syphilis. Discharged to work on November 4, 1931, with the plate still in place.

CASE 10. G. G. On December 20, 1931, this 28 ye old man fell 60 feet, injuring the whole of his right sid He was brought to the hospital immediately. Examin tion disclosed a compound fracture of the lower third the right tibia and fibula with complete lateral dislocati of the ankle. The foot was blue and discolored. Patie was in shock. He was given a large intravenous injecti of saline with adrenalin. Then 4 hours after the accident complete débridement and replacement of the dislocati was done under spinal anæsthesia. A 3 screw Sherm plate was applied to the fibula and Carrel-Dakin treatme was started with leg in plaster splints and elevated in Cabot splint. Temperature never went above 100 degre Complete circulation returned in foot. On January 1932, union was present, and plate was removed. February 5, 1932, wound was almost entirely healed a patient was walking. He was to be discharged in 10 da

C. *Secondary plating* (6). When the op wound is the size of a 50 cent piece or less and has been decided that the fracture could be m accurately replaced by a direct attack and a plication of a plate than by extension, then bridement of the wound is carried out under lo anæsthetic, Carrel-Dakin technique is institut and an open reduction done later. Novocain per cent, is injected into the skin margins of t wound and proves to be sufficient anæsthetic allow a thorough débridement of such a sm wound. The dangers of stirring up an infecti by the injection of the novocain is negligible w it is done within the first 8 hours after the injur This secondary plating may be done from 10 to 15 days after the injury, the time being decided by the temperature, which must have been normal for 2 or 3 days, and by the condition of the open wound, which must have either healed or be microscopically clean. The limb must have returned to almost normal size, the brush burns healed, and the œdema and ecchymosis subsided. The plate is not applied through the open wound, but a fresh incision is made, away from the wound, the skin margins carefully blocked, the plate applied with non-touch technique and the skin closed over it. In other words, it is treated as a simple fracture. In this series, 71 cases were secondarily plated and in 48 per cent, it was unnecessary to later remove the plate.

CASE 11. M. B., aged 28 years, was injured Nove ber 12, 1928, by being struck on left leg with a chain. H was admitted to Youngstown Hospital where it was f nd that he had a compound, oblique fracture of tibia nd fibula 4 inches above the left ankle. Débridement was carried out and position of bones improved by a sed reduction. Carrel-Dakin treatment was carried out the two compound wounds. Owing to the fact that ere was ¾ inch shortening in tibia, man was sent to W ern Pennsylvania Hospital on December 7, 1928. Exa na-tion revealed two healthy compound wounds on wer part of left leg. Temperature was normal. On day fter admission an open reduction was done and a 4 rew Sherman plate was applied to tibia and operation und was closed. Carrel-Dakin treatment was continued the

compound wounds until healing took place January 2, 1930. Patient made an uneventful convalescence, except for a general dermatitis of whole body due to a sensitivity to picric acid which had been used in preparing his leg. February 12, 1929, patient was walking with brace applied to leg; good union. March 19, 1929, he was discharged with 80 degrees' knee motion and plate still in place.

Case 12. G. G., aged 28 years, was injured January 30, 1929, by being crushed between battery machine and oven door. The right thigh was bleeding profusely from two puncture wounds. These were cleansed, packed with Dakin's gauze, Thomas splint applied, and the man was transferred to Western Pennsylvania Hospital. Examination showed the whole thigh crushed, puncture wounds on anterior and posterior part of right thigh. The distal fragment of femur was displaced backward with 2½ inches overriding. A Thomas splint with Buck's extension was applied after immediate débridement of both wounds, under novocain 1 per cent. Carrel-Dakin treatment was applied to the two compound wounds. On February 12, 1929, temperature had been normal for 2 days, and as closed reduction was not satisfactory, under spinal anæsthesia an open reduction of the femur was done, away from the compound fracture wounds. A 6 screw Sherman plate was applied and the wound was closed. The leg was put up in Thomas splint in 45 degrees flexion. There was no postoperative temperature rise. On February 17, 1929, knee motion was commenced by patient elevating and lowering the Pierson attachment to Thomas splint through 45 degrees. Hair-line reduction of fragments was shown by X-ray film. On April 17, 1929, firm union was noted and both wounds were closed. The Sherman plate had not been properly tempered and broke at the site of fracture. On May 1, 1929, patient was walking with caliper splint. On May 21, 1929, the broken plate was removed and the wound was closed tightly. On July 20, 1929, the patient was discharged to light work with 85 degrees motion in knee.

Case 13. L. T., aged 35 years, was injured January 14, 1929, by slipping into a ditch. He received a wound on the left lower leg, which was cleaned, a splint was applied at the mill and the man was sent to Western Pennsylvania Hospital. Examination disclosed a compound, comminuted fracture of the lower third of the left tibia with a wound the size of a 10 cent piece. The bones were not in contact. The leg was placed in Cabot splint after a débridement was done under novocain, 1 per cent, on admission. On January 25, 1929, when swelling had subsided and temperature had been normal for 3 days, an open reduction was done at a point away from the wound. A 4 screw Sherman vanadium steel plate was applied. The leg was put up in lateral coaptation splints, Carrel-Dakin treatment was carried out on the open wound, with the leg elevated in a Cabot splint. On March 12, 1929, he was receiving physiotherapy, and firm union present. Operative wound had healed by primary intention and original wound healed 2 weeks after operation. On March 21, 1929, he was walking in a leg brace. On March 26, 1929, he was discharged and on April 18, 1929, he returned to work.

Case 14. B. C., aged 27 years. On April 30, 1931, at 7 a.m. patient was crushed by a steel "buggy" receiving multiple injuries to the left leg. His wounds were cleaned and a Thomas splint was applied at the mill emergency hospital. The man was then transferred to the Western Pennsylvania Hospital. Examination revealed a 2½ inch laceration on the inner side of the left thigh, the tissues were crushed and torn in the left popliteal space. The middle third of the left tibia showed a compound wound the size of a 25 cent piece on the lateral surface. The distal

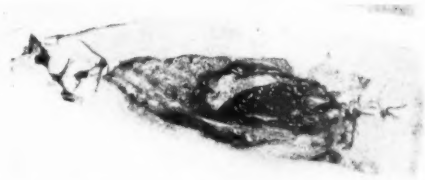


Fig. 21. Photograph of compound, comminuted fracture of tibia, showing an extensive wound partially closed; Sherman plate in place; lateral plaster splints applied in such a way that the wound could be dressed without removing the splint. Carrel tubes which entered every part of the wound are not shown.

fragment was displaced backward and there was no contact of surfaces. Kahn reaction 4+. At 12 noon on April 30, under spinal anæsthesia débridement of the lacerations and wound was done and the laceration about the knee was closed. The fractured bone ends were replaced as accurately as possible and Carrel-Dakin treatment commenced on the open wound. On May 7, 1931, another attempt was made at closed reduction but check X-ray pictures showed that a sufficiently accurate reduction had not been obtained. On May 14, 1931, temperature was normal for 2 days and an open reduction was done with non-touch technique about 1½ inches away from the compound wound and the operative wound was closed tightly over the 4 screw plate. Carrel-Dakin treatment was continued to open wound and to crushed area in popliteal space. There was no rise in temperature after operation. On June 30, 1931, good union was found with plate in place. The wound healed. Thiersch grafts were put in place over the microscopically clean area in the popliteal space. On July 10, 1931, active motion with treatment by Morton Smart machine was begun. On August 27, 1931, the man was walking without a leg brace or cane and was discharged to work on October 2, 1931.

Case 15. W. F., aged 43 years, was injured August 31, 1931, when a steel beam fell on his right leg; at mill hospital wound was cleaned gauze saturated with Dakin's was applied to the wound and a Cabot splint applied. Examination revealed a compound, comminuted fracture of the lower half of the right tibia and fibula with fragments in poor position. The wound was thoroughly excised and cleansed under novocain 1 per cent and Carrel-Dakin technique was begun 3 hours after injury. On September 10 after temperature had been normal for 3 days and ecchymosis had subsided, an open reduction was done at a part away from the compound fracture wound. A 4 screw Sherman steel plate was applied and the operative incision was closed. On November 5, 1931, firm union was present. Treatment was begun with the Morton Smart machine. The compound fracture wound healed. The man was greatly troubled with psoriasis. On November 20, 1931, the man was walking well, with a leg brace applied, and 75 per cent motion was noted in the knee and ankle. December 29, 1931, for the past week there has been a slight serous discharge from the operative wound and since it was necessary to remove some hæmorrhoids, it was decided also to remove the plate. This was done and the screw holes were curetted. Carrel-Dakin treatment was instituted, and the wound was completely closed, with free motion in knee and ankle on discharge from hospital on January 29, 1932.

Armamentarium (14). To obtain good results in reducing and plating fractures, one must treat the

soft tissues and bones with great respect, otherwise the contused tissues will more readily succumb to infection. Much can be accomplished by having the proper equipment with which readily and easily to reduce these fractures, with the minimum of trauma. To accomplish this one should have available, Lane bone-holding forceps; Lambotte bone and plate-holding forceps; Lowman bone clamps; bone skids; Smith-Petersen forceps; Berg forceps; Stille-Sherman bone drill, and a wide variety of Sherman vanadium steel plates and screws. In certain instances, a Berg bone traction clamp is an essential instrument, as with it a fracture very difficult to reduce, is slipped into place easily and without trauma. A well prepared and stable (12, 13) Dakin's solution is the most important single item in the whole armamentarium of the treatment of compound fractures. The solution used in the treatment of these cases and referred to above as Dakin's solution, is a 0.45 to 0.5 per cent sodium hypochlorite in hypertonic saline, this being a non-toxic, non-caustic, and non-irritating solution which has a high bactericidal power. In addition, the solvent properties demonstrated by this fluid, its ability to dissolve and wash away necrotic tissue, old blood, etc., aids materially in cleaning the wound. A commercial product by the trade name of "Hyclorite,"[1] the active ingredient of which is sodium hypochlorite 4.05 per cent, is the solution used in this clinic for the making of Dakin's solution. Seven parts of sterile water are mixed with one part of "Hyclorite" to obtain the proper solution. This is made up daily and titration is unnecessary. If the solution is too caustic, it is possible that it might absorb fresh callus, forming in fractures and Clay Murray (11) asserts that this has happened in some cases of compound fractures under his care, but certainly in this large series there has been no retardation of the formation of callus due to the irrigating fluid.

The dangers of non-union, osteomyelitis, cellulitis, and septicæmia have been stressed by many writers when any observations are made regarding the advisability of openly reducing and plating compound fractures. In the early days of the war the British Army applied many steel plates in treating compound fractures, and it was later necessary to prohibit such practice. The reason for the untoward results leading to the abolition of the plates was that débridement was not carried out, nor was the Carrel-Dakin technique for the treatment of wounds known. Without the benefits of débridement or the knowledge of the Carrel-Dakin technique, similar results would have been obtained in these cases, but it is the combination of these two procedures that eradicates the great danger in compound fractures—infection. Many writers both in the United States and abroad have based their judgment on the open reduction or plating of compound fractures on the results obtained during the early days of the war and not on the results obtained through the application of knowledge later developed. A Sherman vanadium steel plate or screw was applied in this series of cases when it was felt that such would give more accurate apposition of the fragments than could be secured in any other way. No hesitancy (10) was felt in applying a plate to the bone, but rather a feeling of security, knowing that the chance of the bone becoming displaced was reduced to a minimum and that the more accurate the contact of the fragments, the less the chance of non-union. There were no instances of septicæmia, no cases of frank osteomyelitis, and no deaths due to infection in this series. Two patients only of the entire series died: 1 from pneumonia 5 weeks following an open reduction of a fractured tibia; the other from shock following a bone graft of the radius, 6 months after his original injury. In but 1 case an amputation was done on a tibia, plated 5 weeks previously. This was necessary, due to the extensive trauma of the soft parts and blood vessels, with massive destruction of the bone, and not due to any infection. In many clinics, the amputation would have been done immediately and, as it later proved, this was the procedure which should have been carried out. *The other three hundred and one cases returned to work in the mills, mines and railroads, with good function.*

Incidence of chronic osteitis. In this series, if a discharging sinus was still present at the site of fractures or operation 4 months after injury, it was assumed that chronic osteitis was present. This frequently consisted of only a small sequestrum and the sinus cleaned up rapidly after a sequestrectomy was done and the diseased bone was removed.

There were 22 cases of chronic osteitis in 150 cases of compound fractures which were subjected to débridement on admission, kept clean with Dakin's solution, and treated by traction or splinting. Seventeen patients developed chronic osteitis in 154 cases which had been openly reduced and in 129 of which a plate had been applied (Table I).

Briefly, there was a discharging sinus present 4 months after injury in 11.6 per cent of the plated

[1] Approved by the American Medical Association Council of Pharmacy and manufactured by the Bethlehem Laboratories.

TABLE I.—CHRONIC OSTEITIS IN COMPOUND FRACTURES

	Cases	Osteitis	Per cent
Openly reduced and plated			
Primary plating	58	9	15.5
Secondary plating	71	6	8.4
Combined per cent	..	..	11.6
Openly reduced			
Not plated	25	2	8.0
Not openly reduced			
Traction	52	10	19.2
Splinting	89	12	12.2
Combined per cent	..	..	15.7

cases and in 15.7 per cent of the cases treated by traction or splinting. These all eventually healed.

Incidence of non-union. Non-union was assumed to be present in this series, if the fractured bone was not firmly united 6 months following the injury (Table II).

In these 9 cases of non-union only one case had any evidence of syphilis and as 14 per cent of these injured men do have a positive Wassermann, it is felt that syphilis played no part in the failure of the bones to unite. All of these non-unions were treated by bone grafts with subsequent union, except the man who died of shock on the day of his operation.

To be absolutely fair, one must point out that the most severely comminuted fractures could not be plated, and this fact probably raised the percentage of chronic osteitis and non-union in the unplated fractures, owing to the fact that these two conditions more often develop in badly comminuted compound fractures.

Removal of plates. It has been our custom to remove the steel plates from compound fractures as soon as union has occurred. If, however, the wound heals with the plate in place and it is not troubling the patient, the plate is not removed. In this series of 58 primary platings, the plate was left *in situ* in 7 cases (12 per cent). In 71 cases of secondary platings, the plate was left in place in 34 patients (48 per cent). In simple fractures in our hospital the plate is rarely removed but remains untouched in at least 95 per cent of the cases.

In a review of these hospital records for this 15 year period (1917–1932), certain gradual changes were noticed in the method of treating compound fractures. One of the most noticeable was the fact that traction with moleskin adhesive has largely been supplanted by the surer traction of tongs or wires. This is especially true in compound fractures in which the irrigating fluid serves to loosen the adhesive too frequently. The length of complete immobility has also been greatly shortened and active motion and graduated muscular exercise with the Morton Smart (15) machine, is begun even before there is X-ray evidence of callus and when manipulation shows only a fibrous union to be present.

TABLE II.—NON-UNION IN COMPOUND FRACTURES

	Non-union Cases		Combined Per cent
Openly reduced and plated			
Primary plating	58	1	1.5
Secondary plating	71	1	
Unplated fractures			
Opened	25	..	
Traction	52	3	
Splinting	98	4	4.

Diathermy has been dropped as a means of stimulating fracture union, whereas, 8 years ago it was felt to be essential to rapid repair.

In this series the open wound of the compound fracture was so extensive that 24 of the cases had full thickness skin grafts put in place to close the wound with the minimum of scar, especially when the scar was over the tibial crest, where the blood supply is poor and ulceration is prone to develop. In extensively scarred wounds over ununited bones, pedicle skin flaps were routinely put in place before grafting, in order that the increased blood supply of the surrounding tissues would more certainly nourish the graft.

Any attempt at a review of the literature (1, 3, 5, 7, 9) written on this subject during the past 10 years, would be foolish in the extreme, as a wide variety of men working under divers conditions advocate many different methods of management. The trend in the past few years has undoubtedly been toward the more accurate apposition obtained by openly reducing these compound fractures when necessary. This, combined with the Carrel-Dakin method of wound sterilization, not as a treatment after infection has set in, but as a prophylaxis as soon as the injury is incurred, gives the surest and safest method of handling compound fractures.

Dr. W. O'Neill Sherman organized and supervised the method of treatment of almost all of these patients, and it is with his gracious permission that I am reporting these cases. To Dr. Sherman and to Dr. J. Huber Wagner, who also operated on many of these cases, I wish to express my sincere thanks.

SUMMARY

1. A series of 304 cases of compound fractures of the long bones of which 129 were openly reduced and plated.

2. The Carrel-Dakin technique was used in all cases to keep the wound clean and healthy, and in addition accurately to appose the fragments, an open reduction and plating was done when necessary.

3. The percentage of cases of non-union and chronic osteitis in the unplated fractures was greater than in the fractures which had been plated.

4. This series shows that the accurate open reduction and plating of a compound fracture in addition to the use of the Carrel-Dakin method of wound sterilization to the wide open wound tends toward rapid union without infection, rather than toward infection, non-union, septicæmia, amputation, or death.

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CONFERENCE ON TRAUMATIC SURGERY

INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

FRANKLIN H. MARTIN, M.D., F.A.C.S., CHICAGO
Director General, American College of Surgeons

THE Board on Industrial Medicine and Traumatic Surgery had its genesis during the Great War. Traditions and theories were ruthlessly cast aside. It was necessary to execute tasks expeditiously and efficiently, and with the greatest economy of management, money, and man power. It was advantageous to the government to develop every facility that would preserve health. Hence a committee on industrial medicine was organized by the Medical Section of the Council of National Defense.

In a word, this program demonstrated as never before that the employer and the employee could accomplish most if they worked harmoniously. The great leaders of industry, of labor, and of insurance composed their differences, to the great benefit of all concerned. This war experience was a progenitor of the Board under whose auspices this conference is being held.

In 1922, Dr. Daniel Z. Dunott convinced the Association of Railway Executives that railway employees would receive the most efficient care in hospitals approved by the American College of Surgeons. Forthwith, by proclamation to the railroads, this association suggested that the employees of railroads, so far as possible and practicable, should be treated in approved hospitals.

At the organization meeting of this Board, held during the Montreal Clinical Congress in 1926, an important first principle was recognized. The leaders of industry, of labor, of the insurance and indemnity companies, and of compensation commissions must harmonize their interests. And it is an outstanding slogan of the College that if we can convince the heads of these groups we will be insured of the full, unqualified co-operation of assistants and associates. This principle is sympathetically endorsed by your chairman, Dr. Besley.

The real work is already under way. We have held our conferences each year, and by correspondence we are in touch with everyone interested in the progressive work of this Board. During the past year two medical men have secured first-hand information from the four groups with whom we must deal.

Up to this time we have been a fact-finding organization. It is our purpose to plan for the future. And we must all co-operate if we are to be of aid and if we are to solve the problems of industrial medicine and traumatic surgery.

SUMMARY OF A SURVEY OF MEDICAL AND SURGICAL SERVICE IN INDUSTRY IN NORTHWESTERN UNITED STATES

E. W. WILLIAMSON, M.D., CHICAGO

THIS report is based on a survey of 375 industries of various types in the central and eastern sections of the United States, the majority of which maintain a payroll of five hundred or more employees. Approximately three quarters of a million people are employed in these 375 industries; 178 companies (47 per cent) carry their own compensation insurance; 166 (44 per cent) are insured by indemnity companies; 31 (9 per cent) operate under the state fund or have rejected the compensation act and are subject to the common law.

The following summary is based on the application of the Minimum Standard for Industrial Medicine and Traumatic Surgery as formulated by the College:

1. *Medical staff.* Industries have evolved various plans for the care of injuries incurred during employment; of the 375 industries reported, 58 plants engage one or more full time physicians

and maintain complete dispensary facilities; 156 have part time physicians and operate a first aid room for the care of injuries and minor illness, while 161 have physicians only on call with limited or no facilities in the plant for medical care.

Plants which employ full time or at least half time physicians receive the benefits of active medical supervision and a more extended medical service, such as pre-employment and periodic physical examinations, diagnosis, and a service in preventive medicine. The physician is entrusted with the administration of the department.

Where the industry relies upon the services of a physician who is on call only, there is little or no medical supervision. The reduction of employment this year has changed the status of many physicians from a part time to a call basis and under such conditions the nurse must assume more responsibility in providing relief and in deciding which cases should be sent to the physician for treatment. Injuries referred to a physician are usually treated in his office, so the plant operates for long periods of time without a visit by the physician. He is out of touch with the personnel and his only interest and responsibility lies in the care of the occasional patient who is referred to him. This type of organization of the medical service is too remote to be efficient.

2. *Membership on the medical staff.* The requirements for membership on the medical staff, as stated in paragraph 2 of the Minimum Standard for Industrial Medicine and Traumatic Surgery are fulfilled by the appointed physicians in almost all the industries visited. In two plants where no medical director is employed, the condition had arisen that non-medical practitioners were authorized to treat compensation cases outside the plant dispensary.

3. *Clinical records.* Many industries have a well organized and complete record system. It was found, however, that in dispensaries of a large number of industries which employ an indemnity company to carry the compensation insurance, the clinical records consist only of reports of cases treated in the dispensary. The employer is wholly dependent upon the carrier for the reports of cases treated in the surgeon's office or hospital. These records may be needed for reference in years to come, perhaps after a change in insurance companies has been made; therefore, records of all cases should be filed in the office or dispensary of the industry.

4. *Hospitals.* Where the operations of the industries are centralized, one or more leading hospitals located conveniently to the plant are designated for the care of accident cases. This type of industry uses only a small number of hospitals and the most of these are on the approved list of the College.

Companies which have a decentralized personnel, such as public utilities, usually specify that the injured employee be taken to the nearest hospital. The result of this arrangement is that a large number of institutions is used and the choice is made on the basis of proximity to the scene of accident rather than upon the rating of the hospital.

Aside from location, the selection of non-approved hospitals may be made by the employee who is not informed, by the physician who does not discriminate, or by the one who pays the expenses because the rates may be lower. Industries should know more about the merits of an approved hospital and the reasons for the statement in the Minimum Standard that all patients requiring hospitalization shall be sent to approved institutions.

5. *Medical supervision.* Only the larger industries with physicians on a part time or full time basis have arranged for medical supervision of plant sanitation and health of employees. Plants which have the hazards of occupational disease are the most active in carrying out rigid measures in sanitary inspection and periodic examinations of employees who are exposed to these hazards.

There are problems arising in connection with the handling and settlement of occupational diseases which authorities state are much more difficult to solve than adjustment of compensable injuries. Many companies, especially the larger ones, which have operated under direction of the compensation law for 20 years, have carried on effective programs in the prevention of accidents and the care of injuries to the extent that loss of time and compensation therefore have been reduced extensively. Within some of these companies there are certain occupational diseases, such as silicosis, which are creating new and difficult situations. The affected trades are looking to the medical profession for assistance and a solution of these problems.

6. *Scope of medical service.* Only a small percentage of industries included in this survey extend medical treatment beyond the care of injuries and emergent and minor illness arising during working hours.

Of the 375 plants visited 320 maintained a dispensary with facilities sufficient to supply the specified service. The results of our studies show further that 241 (64.2 per cent) of the industries provide pre-employment physical examinations, while 115 (30.6 per cent) have periodic examina-

tions of all or certain groups of workers, 290 companies (77.3 per cent) have some form of benefit plan in operation, such as: (1) a mutual aid association maintained by the employees alone or on a contributory basis. The benefits are weekly cash allowances for a stated period payable for loss of time due to illness and non-compensable injuries. Only a small percentage of these associations provide the doctor's services. (2) A relief plan maintained by the company. (3) A group insurance plan which provides benefits for total disability and death, and in a small number of cases an allowance is provided also for illness and non-industrial injuries.

1932 SURVEYS OF MEDICAL SERVICE IN INDUSTRY

M. N. NEWQUIST, M.D., CHICAGO

DURING the past year surveys have been made of the medical departments or services of varied industries at selected points in most of the United States. The purpose of these surveys, as directed by the Board on Industrial Medicine and Traumatic Surgery, is to get the facts in regard to such medical service, to advance the efficiency of the service, and to promote a better working co-operation between industry and the medical profession.

The surveys included 246 industries, representing a total of one million sixty-two thousand employees or an average of four thousand employees each. Thirty-six per cent of the total employees involved had payroll deductions to provide complete medical and hospital service on some contract arrangement, and in 6 per cent the families were included in this service. Seventy-five per cent of the industries visited had physicians either on a part time or full time basis, and 70 per cent gave pre-employment physical examinations. Further organization for the provision of medical service appears to be inevitable. If the 36 per cent of employees mentioned wish to be served medically on some group insurance basis, would it not be possible and advisable to link up the doctor in some form of harmonious participation but still retain his identity and private status?

The plans and facilities for medical service ranged from no facilities or organized service whatsoever in the smaller industries to well equipped dispensaries and competent medical staffs in the larger or more hazardous industries. Most of the larger industries should be given credit and recognition for adequate care of their industrially ill and injured employees. To the smaller industries whose medical service is less efficient, the efforts of the College in industrial medicine and surgery should be directed.

Contract medical practice which originated in isolated industrial communities has received considerable impetus under the stress of the present prolonged economic depression. The following conclusions in regard to contract practice are based upon observation and upon direct information from those who are involved in the practice:

Among the good points may be mentioned:

1. The Group Insurance principle is utilized to provide medical care at low cost.
2. It gives the employee and the employer a sense of security.
3. Experience in this restricted field makes those that practice it more efficient.
4. Special facilities and full time service for the care of ill or injured are usually provided.
5. It fixes responsibility, which is naturally considered an advantage by the employer.
6. Uniform and prompt reports are rendered to the industry and to the State Compensation Department.
7. It is a plan that can compete with the present day method of installment buying.

Among the weak points and abuses are:

1. Solicitation. In practically every instance there has been more or less solicitation either by the doctors or by paid lay-solicitors.
2. Price cutting and bribery resulting in typical price wars.
3. It denies a reasonable latitude of choice of doctors or hospitals.
4. It permits the extremes of inferior medical and hospital services.
5. Unfair competition with the independent practitioner.
6. Unreasonable demands made of the doctors.
7. Commercial exploitation of the profession. Commercial and other lay corporations are found practicing medicine.
8. Medical and hospital service under contract practice is not always restricted to the low wage earner.

It would seem that contract practice has its good points but inasmuch as it is subjected to so many abuses no blanket endorsement can be made of this type of practice. Each case must be judged upon its own merit.

INJURIES TO THE LUNG

AMBROSE L. LOCKWOOD, M.D., C.M., F.A.C.S., F.R.C.S. (CAN.), TORONTO, CANADA
Lockwood Clinic

IT was a great tragedy, far beyond the imagination of any, except medical officers with long service in advanced operating centers, that not until the summer of 1916, after 2 years of intense fighting, were the possibilities of more radical intrathoracic surgical interference appreciated. In those 2 years thousands of lives were sacrificed that could have been saved if thoracic surgery had advanced as had surgery of other parts of the body. The success of that great master surgeon John B. Murphy and Sir William Macewen in dealing with intrathoracic disease under ordinary general anæsthesia was entirely overlooked. The effort of Sauerbruch and his followers with the negative pressure chamber, although it contributed somewhat to the advance in surgical technique of intrathoracic problems, served mainly to cloud the issue and render more absurd our knowledge of the physics of the chest and increased the temerity of surgeons in dealing radically with intrathoracic conditions.

For 2 years of war we had watched hundreds of young men, the flower of the manhood of the nations die of chest wounds. Certain types of gunshot wounds of the chest were considered "necessarily fatal" and practically one hundred per cent of patients with such wounds died within 1 hour to 48 hours of being wounded. Approximately 78 per cent of all patients with thoracic wounds died. Largely as a result of the work of one surgeon in the French Army and two surgeons in the British Army—in the summer of 1916 and almost simultaneously, although working separately, the safety of radical intrathoracic surgery was determined and the mortality even in the so-called one hundred per cent "necessarily fatal" cases was reduced to 27 per cent. The vast number of such wounds dealt with during the last 2 years of the war firmly established the fact that the thorax could be widely opened, its contents be freely handled and dealt with, with less risk than in the routine abdominal procedures.

In addition, the convalescence was more rapid and complete and soldiers could be returned to their units for duty, earlier than was the case in gunshot wounds of the abdomen, head, or extremities. This was no small consideration where man power was being so constantly and rapidly destroyed. Lest we forget, may I point out that during the months of July, August, and September, 1916, sixty-two thousand stretcher cases, entirely apart from walking-wounded, passed through our Casualty Clearing Station on the Somme front. Ninety beds were set aside for men with gunshot wounds of the thorax, whom the reception officers thought had a chance to recover. It was a distressing duty day after day, as chief surgeon, to make hurried rounds of these patients and consign to the moribund ward those we knew would die within the next few hours. Appalled by our helplessness in dealing with wounds of this type, and the distressing and inevitable outcome up to that period, and fortunately perhaps without any time or opportunity for confirming our conclusions by animal experimentation, we decided about the middle of July, 1916, to attempt to deal radically with the so-called "necessarily fatal" type of gunshot wounds of the chest. Within 1 week, 11 so-called fatally wounded men, had been operated upon and were still alive. From that time on gunshot wounds of the chest in our Unit were considered as emergency surgical cases. They were immediately sent for admission to the resuscitation wards and we realized that chest cases requiring early operative treatment required it as urgently and as promptly as did abdominal cases. Operative interference became routine treatment. Our dread of such cases decreased as new experiences proved the value of radical treatment, until by the autumn of 1916, we found that we had reversed our mortality and instead of helplessly watching 78 per cent of these unfortunate patients die, we were saving 78 per cent of them (Lockwood and Nixon, (1)).

Thanks to the far-sighted policy of our Director General, the Adjutant-Director of our particular army, the IV British Army and the consultants, we were permitted to retain all chest cases after August, 1916, whether seriously or slightly wounded, until they were up and about, and able to do light duty. In addition, our own Casualty Clearing Station and that of Colonel Pierre Duval, now professor of surgery in Paris, were placed side by side. We worked in the closest of harmony, and as he had been responsible for the development of thoracic surgery in the French Army, we were mutually afforded an unrivaled opportunity to study our respective methods of dealing with such wounds. To Duval and his associates, my associates and myself will be forever grateful for

their great courteousness at all times, and for constant help and advice on matters surgical.

From 1915 to 1920, as a result of the tremendous casualties of the War and the dreadful epidemic of influenza in 1918 and 1919 with its high percentage of empyema, thoracic surgery developed to a greater extent than it had in all previous time.

The successful treatment of empyema, lung abscess, bronchiectasis, tumors of the chest, surgical procedures on the heart and pericardium, the lungs, mediastinum and diaphragm and now successful operations for removal of the clot in pulmonary embolus, present an unparalled galaxy of surgical achievement in the last 17 years.

It is a question if the profession generally, even yet, realize the great advances in the treatment of injuries of the lung made during that period, and the urgency and possibilities of treating such wounds in civil practice. A definite percentage of deaths after automobile and flying accidents, train wrecks, falling from a height, crushing injuries, and penetrating wounds of the chest are avoidable, if proper care is given.

At the outset the chief problem to be faced is the recognition of those patients who recover without operation as distinguished from those who unless operated upon, inevitably die. Speaking broadly, the cases in which we advise a complete intrathoracic operation, belong solely to the latter group.

It is not within the scope of this address to consider all types of traumatic lesions of the thorax. It must be appreciated, however, that most of the deaths due to thoracic injuries are due to extensive injuries to the bony skeleton of the thorax, the so-called "stove-in" chests. Such patients die as a rule from the shock and exhaustion of the gross bony lesions. Injuries of the lung resulting from such accidents and conditions that should be recognized are:

1. Rupture of the visceral pleura causing: (a) spontaneous pneumothorax in a "closed" chest; (b) associated with an open pneumothorax —traumatopnœa; (c) the degree of displacement of heart and mediastinum in either condition.
2. The presence of a hæmothorax—if so, how extensive?
3. A hæmatoma of the lung.
4. Rupture of a main bronchus or blood vessel with escape of air or blood into the pleural cavity or mediastinum.
5. Contralateral collapse.
6. Massive collapse of one or even both lungs.

Traumatopnœa should be immediately sought for. If present, the wound should be cleaned and without an anæsthetic the skin should be sutured with deep silkworm gut sutures or be approximated and sealed over with adhesive plaster. The immediate improvement in such patients is often marvellous within a few minutes. The lung usually expands, the respirations become deeper, freer, and more regular, and the mental distress of such a wound is at once relieved. Such a patient can shortly be safely transported to a hospital for closer observation and further treatment.

Massive collapse of one lung and even of both lungs without any gross injury of the bony thorax occurs. This condition, particularly that of bilateral collapse, we did not recognize until July, 1918, in the Ypres salient. The cause of it is difficult to explain unless due to sudden withdrawal of air due to bursting of a shell, with perhaps one intense expiratory effort and bronchial spasm. The lung or lungs were found contracted on their pedicle and were not larger than one-third of the man's fist. While an excised portion would float, there did not seem to be any air whatsoever in the entire lung. In such a case, the involved side is found to be absolutely silent. Place a handkerchief or a piece of gauze over the mouth, compress the nostrils of the patient, apply your own mouth to that of the patient, and blow air into his lung. The lungs can be inflated instantly, and with alternate blowing and pressure on the chest respirations can be restored. We no longer employ a pulmotor, even for a patient suffering from asphyxiation.

Morphia in fractional doses should be freely administered and active resuscitory measures taken to combat shock. Intense dyspnœa due to hæmothorax or pneumothorax should be relieved before operation by aspiration. If recurring hæmorrhage is suspected, the aspiration should be partial and combined with oxygen replacement.

Diagnosis. As soon as the patient's condition permits, he should be thoroughly examined by the surgeon, physician, and radiographer, to decide whether or not immediate operation is required.

Roentgenological examination. Roentgenological examination reveals the approximate amount of hæmothorax, the presence of pneumothorax, hæmatoma of the lung substance, the degree of collapse of the lungs, the position of the diaphragm, heart and mediastinum, and the comminution and overriding of the ribs.

Clinical symptoms and signs. The physical examination should be limited in the first instance to ascertaining whether an immediate operation is advisable and possible.

Widespread surgical emphysema obliterates or disguises every other physicial sign except the position of the heart.

Physical signs in traumatic lesions of the lung are most fallacious. Unduly moving the patient to permit of a meticulous physical examination is very unwise, and the findings should not influence the decision to operate if certain indications for surgical interference exist. The bizarre findings on physical examination of traumatized chests must be realized by the examining doctors. Respiratory distress does not always accompany even the largest effusions. The degree of movement in a chest is not always proportionate to the intrathoracic injury. Immobility may be complete without an intrathoracic lesion. Pneumothorax does not always develop rapidly after injury: it may be a late and gradual occurrence.

It has been a mystery to us why hæmothorax so constantly develops in chest injuries. Seldom have we found an intercostal artery ruptured, or at least still bleeding; rarely, if ever, have we seen active bleeding from a contused or lacerated lung except when it is held up by adhesions. Excision of a wound in the lung is associated with remarkably little hæmorrhage.

Signs of increasing effusion, in patients treated expectantly, after 24 to 36 hours, are rarely ever due to active hæmorrhage. Late secondary hæmorrhage is, as a rule, due to bleeding from an intercostal artery.

Indications for operation. 1. Operate on all patients with an open pneumothorax (traumatopnœa).

2. Operate on all patients with laceration of the diaphragm as well.

3. Operate on all patients with a badly "stove-in" chest, with overriding fragments and sharp spicules where the pleura is lacerated, even though there is no external wound.

4. Operate on all patients where a jagged irregular missile has traversed the pleural cavity, whether lodged in (a) the chest wall, (b) the pleural cavity, (c) the lung, (d) the mediastinum, or (e) the heart or pericardium.

5. Operate on all very acutely infected patients, even though the missile is not retained.

6. Operate on all patients with a penetrating wound of the chest with progressive bleeding, hæmoptysis, and massive hæmothorax.

7. Operate on all patients with a massive pneumothorax and great displacement of the heart and mediastinum that cannot be controlled by aspiration.

8. Operate on all patients in whom rupture of a main bronchus or artery at the hilus of the lung is suspected.

Thoracotomy is rarely indicated for relief of the ordinary hæmothorax or hæmatoma of the lung. Unfortunately, occasionally lung abscess or more rarely gangrene of the lung results from an extensive hæmatoma of the lung, but unless thoracotomy is necessary otherwise, we believe such patients should be treated expectantly.

Anæsthesia. Surgeons dealing with thoracic problems should have a thorough knowledge of the physics of the chest. So many fallacies have been propounded based largely on experimental studies on dogs and rabbits! Such findings have little if any value as applied to humans. The mediastinum in the dog and the rabbit is permeable to air and even fluid, but that of humans is impermeable and has a certain degree of fixation. Our decision to deal radically with intrathoracic wounds in 1916 was based on the fact that investigation on cadavers had established the fact that the mediastinum of humans was not permeable to air or fluids and presented a fairly rigid barrier between two cavities. Snyder's (2) investigations in 1927 corroborate our experiences of 1915 to 1919.

The modern gas oxygen machines with a snugly fitting mask applied to the well vaselined face affords all the positive pressure necessary for re-oxygenation and offsets the danger of a prolonged open pneumothorax. Intratracheal gas oxygen anæsthesia in the hands of an experienced anæsthetist, should be employed for a prolonged thoracotomy.

A paravertebral anæsthesia for two or three spaces above and below the wound or the site of the incision, with local infiltration, to avoid delay, associated with gas oxygen analgesia, is the anæsthetic of choice. Emergency cases that would never be fit for a general anæsthesia can be safely operated upon with this type of anæsthesia. A more extensive, deliberate, and protracted operation can be undertaken with the minimum of shock to the patient. Respirations are deeper and more regular than with a general anæsthesia, and the movements of the lung, mediastinum, and diaphragm can be voluntarily controlled by the patient to an appreciable extent. The two stage operation in which both sides of the thorax are opened, is possible only with this type of anæsthesia. Postoperative restlessness, vomiting, retching, coughing, and straining are avoided, and this plays no small part in the success of such operations, especially in bad risk patients.

Operation. The complete intrathoracic operation must not be lightly undertaken. The preparations for operation, the anæsthetic, and the technique of the operation are most exacting, although the manipulations themselves within the thorax do not require any exceptional dexterity.

Speed is essential. *Absolute asepsis must be maintained.*

For operation the patient should be placed with the injured side dependent, usually in the half-sitting posture. Primary union will not result without bold, thorough excision of wound area.

When the position of the wound will permit, resection of the fourth rib or preferably a long incision in the interspace immediately below from the mid-clavicular to the posterior axillary line furnishes easiest access to the thoracic cavity. A powerful, snugly fitting rib retractor is necessary.

The commonest source of bleeding is from a torn intercostal artery. If the artery cannot readily be picked up and ligated, with a small periosteal needle, a suture can be passed around it or failing that around the rib itself.

The lung can be freely handled, incised, or a wound excised as required. If the wound is of a gaping type in the lung, tags of intercostal fascia and muscle should be laid over the edges and sutures passed through them will relieve tension on friable lung tissue when the edges are approximated. Bronchial fistula will invariably be avoided if the visceral surfaces are carefully apposed.

Partial, or even complete lobectomy may be necessary, depending on the degree of laceration of the lung. In such a case preserve plenty of the visceral pleura.

An open bronchus or alarming hæmorrhage from the lung surface is rarely found at operation.

The toilet of the pleura must be meticulous.

The thoracotomy incision should be closed with a thick, moist towel, every moment that the hands of the operator are not within the thorax.

Time should not be wasted in attempting to repair the parietal pleura.

The chest must be hermetically closed with the first layer of muscles; otherwise, pocketing will occur, pleural effusion accumulate, the incision break down, and an empyema result.

Careful approximation of the skin edges is necessary to insure early, absolute primary union.

Drainage of the chest should never be employed in these primary operations.

Gross injuries of the bony wall of the chest associated with injury to the lung require that all comminuted bone and sharp spicules be widely excised. If the intercostal nerves have been torn, employ alcohol injection proximally to offset pain during convalescence.

Postoperative treatment. The postoperative treatment of chest wounds demands constant attention. The patient should be maintained in the position found to be most comfortable. Oxygen should be employed if the patient is cyanosed. Morphia should be freely used to combat restlessness.

Aspiration should be carried out 18 hours after operation and as frequently as necessary to keep the pleural cavity relatively free of fluid. Early fluoroscopic examination or roentgenograms will help to determine the presence of a collection.

CONCLUSION

1. Grave traumatic lesions of the chest are still being overlooked, and are not being dealt with radically as they should be.

2. First aid instruction as to the necessity, urgency, and methods of immediately sealing off a penetrating wound of the chest to overcome the ill effects of traumatopnœa is advisable.

3. All such patients should be given morphia early.

4. Massive pneumothorax should be looked for.

5. Active resuscitory measures are necessary. In the majority of such cases blood transfusion is required.

6. The urgency of recognizing whether or not the thoracic lesion is the main cause of the patient's condition cannot be overemphasized.

7. The indications for thoracotomy are well defined.

8. The complete intrathoracic operation is a serious one and not lightly to be undertaken.

9. A select anæsthesia must be employed.

10. Speed in operating and absolute asepsis are essential to success.

11. The operation must begin with *excisio in toto* and end with hermetically sealing of thorax.

12. Fluid should not be allowed to collect in the pleural cavity after operation.

13. Resection and drainage secondarily should be a last resort. It is rarely necessary and should be employed only after multiple aspirations and if necessary catheter drainage has failed.

In no class of surgery is teamwork more essential to success. The surgeon, physician, radiographer, and anæsthetist should work hand in hand. The theater staff must have everything prepared in advance and be quick and methodical, knowing each step in the operation, thereby avoiding delay. After operation nurses who are experienced in caring for such patients should, if possible, be employed.

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SILICOSIS AND OTHER DUST DISEASES

C. O. SAPPINGTON, M.D., DR. P.H., CHICAGO
Director, Division of Industrial Health, National Safety Council

A DEPOSIT of silica in the lungs can never be removed. The health hazards to the operators on these dangerous jobs can all be eliminated, not only in such a way as to protect the operator, but incidentally with a saving in production costs.

Silicosis, far from being a new disease, was described by Ramazzini in 1700. The first American study was made by Lanza and Higgins, among the lead and zinc miners in the Joplin, Missouri district in 1914. Of the 720 miners examined, 330, or 45.8 per cent, had silicosis in some stage; 105, or 14.5 per cent, had silicosis with tuberculosis; and 39, or 5.4 per cent, had tuberculosis alone.

Definition and etiology. Silicosis may be defined simply as a specific form of pneumonoconiosis due to breathing air containing free silica dust—identified anatomically by generalized pulmonary fibrosis and the development of miliary modulations in both lungs; clinically, by shortness of breath, decreased lung expansion, lessened capacity for work, increased susceptibility to tuberculosis, and characteristic X-ray findings.

It was formerly thought 10 years' exposure was necessary for its production. Recent reports indicate that cases have occurred within 3 to 5 years' exposure. The Canadian laws are based on an exposure of from 3 to 5 years.

The principal industries in which silicosis appears are (1) mining, (2) quarrying, (3) stone finishing, (4) pottery, (5) abrasives, (6) glass, (7) mineral earth, (8) spray coating, (9) refractories, and (10) construction.

Diagnosis. The diagnosis of silicosis rests on proof of adequate industrial exposure. Symptomatology, physical and X-ray findings; the X-ray findings being the most important.

In the *symptomatology* the outstanding preliminary complaints are non-productive cough and shortness of breath. These symptoms become more pronounced as the disease progresses. The X-ray evidence is characteristic.

Pathology. According to Gardner, in the initial stages, the phagocytes are apparently irritated by ingested particles, transporting dust particles to points where intimate contact is established with connective tissue cells. Active proliferation of fibrous tissue continues after this stimulation and an extensive reticular network developed. Later in the process a tendency to the development of discrete nodules is observed and hyaline degeneration of the nodules may take place. The normal flow of lymph from the lungs is interrupted by extensive damage and replacement by fibrous tissue in the tracheobronchial lymph nodes, although the original degeneration of tissue is not due to an ischemic effect, but is essentially a local manifestation of the toxicity of free silica or quartz dust.

Prognosis. Prognosis depends upon the stage of development of the disease but is always grave from a curative standpoint when the changes are sufficiently advanced to be recognized clearly. The prevention of silicosis may be accomplished through observance of the following procedures:

1. A careful occupational history, paying particular attention to previous exposure to free silica hazards; the exclusion of those who have had exposure which might be hazardous, the exclusion of the tuberculous, and the refusal of employment to persons who are experienced in occupations involving a free silica hazard.

2. A careful physical examination and X-ray of the chest of all employees before going on work involving free silica hazards.

3. The provision of proper types of exhaust ventilation equipment, adapted especially to the processes involved.

4. Personal respiratory protection of an adequate and approved type, according to the manufacturing processes concerned, with proper provision for maintenance and supervision.

5. A periodic physical examination together with X-ray examination of the chest at appropriate intervals, according to the severity of the exposure, the type of work done, and other detailed factors.

ASBESTOSIS

Asbestosis occurs with considerably less frequency than silicosis, although enough clinical and pathological material is now available for adequate study.

The disease may be defined as a specific form of pneumonoconiosis due to breathing air containing asbestos dust, based on concentration and length of exposure; it is characterized anatomically by a generalized pulmonary fibrosis—clinically by shortness of breath and decreased

lung expansion, and by X-ray findings which differ from those of silicosis.

Lynch and Smith surveyed all available literature on the subject in 1931 and collected 172 cases of pulmonary asbestosis. These observers stated that necropsy has been made in 18 cases; that including the first case recorded (that of Murray in the *Charing Cross Gazette* of 1900) there are now four records of necropsy on uncomplicated pulmonary asbestosis. Most of these cases developed in the British Isles with the exception of a few reported by Simson in South Africa; by Lynch and Smith, and by Pancoast and Pendergraff in the United States. Apparently the first American case recorded was reported by Soper in December, 1930.

OCCUPATIONAL DISEASES

Medicine's Unclaimed Province!

CAREY P. McCORD, M.D., Cincinnati, Ohio
Medical Director, The Industrial Health Conservancy Laboratories

THE first factory in America probably was located in Jamestown, Virginia, in 1609. There Captain John Smith's little bands of pioneers made glass beads and similar baubles for trade with the Indians.

In this primitive foothold of American industry, the threat of occupational diseases existed. Using the sands of the James River, and lye leached from the wood ashes of their fireplaces, these first industrialists, potentially, were exposed to the causes of two occupational diseases that today stand out respectively as the commonest of such diseases and the most direful. Lye long has been a source of occupational skin disease—this country's most common, significant trade affection. Silica dust is the cause of silicosis—this country's foremost industrial disease problem. Occupational diseases thus have grown up with the country.

These two hazards, lurking in the first factory of 1609, have so multiplied until at this very time no fewer than 1,000 dissimilar dangers threaten the well-being of this country's workmen. These hazards are to be found in the vapors, gases, fumes, dusts, toxic liquids, noises, unusual chemical and physical rays, industrial bacteria, and many other creations of this country's far-flung industrial pursuits.

Today, recognition is given to some 7,000 different occupations. Of these, approximately four-fifths are associated with some degree of prospective harm for the exposed workman. This number does not include as prospective, traumatic injuries, which are distinct from occupational diseases, in that commonly they are swiftly produced, while long exposure is the rule in the case of occupational diseases. This may be clarified by the simple example of a workman who uses an air drill in digging up a concrete roadway. A chip of concrete may lacerate the eye, thus immediately producing an obvious accidental injury. On the other hand, day by day vibrations of his pneumatic tool may slowly lead to a tenovitis. This latter is not a fortuitous circumstance, and the condition resulting from the sustained exposure constitutes a characteristic occupational disease. Although time is the essence of separation of industrial accidents from occupational diseases, no fixed time may be set as the demarcation line.

Some justification exists for maintaining that as many as 1,000 distinct occupational diseases may exist. However, while there may be 1,000 distinct causes of occupational diseases, the number of clinical entities is much less, owing to the fact that manifestations are essentially the same for many different industrial affections. Notably, this is true of industrial dermatitis. Some idea of the frequency of cases of occupational diseases may be gained from the assertion that yearly 50,000 cases of occupational skin diseases alone take place. Other forms of occupational lesions are not proportionately large, but in the aggregate the yearly total throughout this country is enormous.

If, in fact, it is proper to recognize approximately 1,000 different occupational diseases, this number is believed to constitute the largest number of diseases falling into any one subdivision of medicine. However, with few exceptions, the number of cases of any one type of occupational disease, in any one community, is likely to be small. No less in every industrial area, week by week happenings like the following are likely to take place:

A. Recently, in one city, a department store worker presented herself to the physician in charge, complaining of asthma. The faithful physician carried out numerous protein sensitization tests from feathers to pollens, without avail. The taking of a more careful work history would have disclosed that this department store worker was employed as a fur worker in the alteration room.

On cheap furs the brown and the black color may be procured through the use of *paraphenylendiamine*. This substance is a well known source of asthma, and this patient was suffering from a characteristic occupational disease.

B. In a low type of tobacco plant, two workmen were engaged in the reclaiming of scrap tobacco. This is a dusty process. Both of the men developed a disease characterized by peripheral neuritis, gastro-intestinal involvement, upper respiratory tract inflammation, and loss of hair.

These two men were suffering from *arsenic poisoning*—due to the fact that in the growing of tobacco the plants are sprayed with an arsenic-containing insecticide. This arsenic is retained on the leaves to some extent, and, given high concentrations of dust, arsenic poisoning is a reasonable expectancy.

C. In many cities the depression has caused persons to engage in dry cleaning on a petty scale. Fire regulations prevent the use of gasoline, Stoddard's solvent, benzol, etc. Frequently, these workers carry out dry cleaning in their homes—or in the rear of some other business building, using carbon tetrachloride as the flame-proof detergent. *Carbon tetrachloride* poisoning may be the result.

D. For a long time, Dalmatian insect powder, which is made from chrysanthemum buds, was dusted about our homes in the elimination of insect pests.

Nowadays, it is customary to leach out the chrysanthemum buds with a solvent such as *ethylene dichloride* or *dichlorethylene*, and to spray the resulting fluid extract into the air. Both the solvent and the powder are toxic, and poisonings have arisen both in manufacturing plants and households. In the former the condition constitutes an occupational disease—in the latter a non-occupational affection.

E. During the hunting season for rabbits we find another example. Among the many butchers who dress rabbits for the market, several may prick or cut their skins—and *tularemia* may develop. Under these circumstances *tularemia* constitutes a clear-cut occupational disease.

F. Many workers, in cleaning up after a day's work, favor the use of abrasive soaps. The abrasive employed is likely to be *silica* or a *silicate*. The makers of this type of soap are far removed from granite quarrying, sandstone cutting, or sandblasting, but no less *silicosis* may arise among them.

G. Saw mill hands are not infrequently engaged in handling logs that long have been floated about in mill ponds. These logs are likely to be covered with a rich growth of *fungi* (molds). Certain of these *fungi* are pathogenic, and pulmonary diseases due to fungi are to be recognized as occupational.

Occurrences of occupational diseases such as the foregoing are frequently taking place all about us. These diseases reach into every specialty in medicine—not excluding surgery. In substantiation, I am citing the following:

A. In an eastern plant a number of workers proved to be suffering from bladder tumors. It was observed that all these workers came from one department. It was further observed that all were working with *benzidine*.

These cases, now under observation, are regarded as *benzidine tumors*, but other derivatives of aniline oil are known to be capable of producing similar neoplasms. These conditions are clearly within the domain of surgery.

B. *Silicosis* is followed, in a high percentage of incidence, by *tuberculosis*. In the treatment of ordinary tuberculosis, surgeons frequently resort to collapse of the lung. At once the question arises as to whether or not tuberculosis in a lung made dense by previous silicosis may be collapsed, and whether or not this is a desirable procedure. At the present time the answer to this question is not known, but some responsibility for the proper solution rests upon the surgeon.

C. *Zinc sulphate*, as formed about galvanizing plants, is quite capable of causing ulcers of the stomach and duodenum. To a lesser extent this is true of other metals and metal salts. The incidence of gastric ulcers among lead workers is considerably higher than for all workers.

D. Many thousands of workers in this country are exposed to *oils* and other *coal tar* or *petroleum derivatives*, containing carcinogenetic agents.

In England the frequency of *tar cancers* among textile workers makes of this a foremost problem. In this country, either the incidence is lower or the recognition of cancers as occupational in origin is not accomplished.

These, and many other occupational disease problems, clearly fall within the domain of the surgeon. Associated with the majority of all trades are clear cut dangers, leading to disabling and life-shortening abnormalities. Something may be gained by citation of one example chosen at random.

The uninitiated are unlikely to see any real dangers in the work of a metal polisher or buffer, sitting or standing for 8 hours a day, bringing various small metal objects into contact with a revolving cotton wheel, or a similar wheel to the edge of which emery powder has been glued. To the initiated, a number of distinct occupational disease hazards exist. These I am briefly enumerating:

1. Lead is nearly always present as an impurity in buffed or polished metals. Some metal parts so treated, are composed entirely of lead, or contain a high percentage of lead, 60 or 80 per cent, for example. Some lead articles are polished and buffed without plating, which means that any metallic dust generated is necessarily lead.

2. Some buffing wheels, or adjuvants used in buffing, are siliceous; particularly is this true in sand buffing. Although the sand may be treated with oils to prevent dust and to promote buffing, siliceous dusts are no less developed and silicosis is known to exist among these workers.

3. The revolving polishing or buffing wheel is never a circle, due to inescapable unevenness. This leads to jerking and pulling on the hands holding the object against the wheel, which may eventuate, and practically does eventuate, in tenosynovitis and kindred inflammations.

4. The polishing materials vary widely, depending upon the metals being finished. Many of these

are skin irritants, of which chromium, used in the buffing of chromium plated articles, is the most dangerous. In other polishes, silica or silicates are included.

5. On certain plated objects coming up to the polishers and buffers, there is a scum or film. This is likely to be partly composed of the plating materials, in spite of the fact that one or more washings may have followed submersion in the plating material. In chromium plating such a film is well known. Here is a small hazard for the production of skin diseases among polishers and buffers.

6. If the objects to be polished or buffed have bright surfaces, as they usually do, they may so reflect overhead lights as thus to produce a specular glare and create an eye hazard for the workman.

In addition to these characteristic hazards, there are certain other important, but non-characteristic, ones. Tuberculosis rates are enormously high among polishers and buffers. The reason for this is perhaps several fold, including the miscellaneous dusts provided, and the posture assumed in polishing and buffing, which limits breathing. This situation is well summed up by Hayhurst, who states: "Especially should medical supervision be adopted for polishers and buffers, as they are at a process which appears to take about 20 to 25 years off of their lives."

In the stream of constructive endeavor in industrial human relations, occupational diseases have long been caught in an eddy. In the causation of this eddy the medical profession has played a prominent and unpraiseworthy part. The reason for this readily may be delineated. The ingenuity of the industrial chemist long has set too rapid a pace for the physician. By the time that the physician has familiarized himself with one set of hazards, the chemist has created substitutes which at times are equally dangerous. By the time the physician came to accept benzol as a highly treacherous solvent—the chemist was thinking in terms of glycols, higher alcohols, chlorinated hydrocarbons, xylenols, etc. The physician seeks refuge in what has now become a medical aphorism—"*Occupational diseases do not lend themselves to ready diagnosis.*" To the contrary, occupational diseases more than any other class of diseases of large numbers, lend themselves to precise and exact diagnosis!

The citation of excerpts from a single case may emphasize this situation:

A few years ago, a patient presented himself at the dispensary of a large hospital, giving his occupation as a windowshade maker, and complaining of a widely distributed skin lesion. In the absence of a positive Wassermann, and because of an earlier history of possible lues, a diagnosis of that condition was made, and this patient was given arsenicals. The condition became worse, and this afflicted patient sought no further treatment.

Shortly thereafter he appeared in another hospital as a house patient, where, after consultation, a diagnosis of Hodgkin's disease was made, for which there was some justification. The physician in charge was advised to remove his patient to a home for incurables, since the prospects of recovery were negligible. However, before actual removal, this patient developed a thrombo-angiitis in an extremity, and a diagnosis of Buerger's disease was made. Later, in the home for incurables, the physician recommended the removal of all teeth, because of oral infection. The patient did not improve. However, after many months, this man apparently did recover and worked for 2 years. During this time a full measure of the true facts had come to light. This patient was, in fact, a windowshade maker. However, he worked as a pigment blender in the windowshade coating room—and analysis of these pigments disclosed a well known intoxicant as an impurity in the majority. This same toxic substance was found in the cut hair of the patient—in his urine—and in his blood. This patient's skin lesion—loss of nails—loss of hair—the angiitis—the bronzing of his skin—all might have been attributed to the action of this intoxicant. *This workman was suffering from an occupational disease—arsenic poisoning!*

It is to be doubted that the defensive aphorism "*Occupational diseases do not lend themselves to ready diagnosis*" is a proper substitute for a generous lot of divine inquisitiveness.

As a result of the general situation contemplated, occupational diseases represent a field of medicine much shunned by the great majority of physicians and surgeons. As a further result, much of the so-called "authoritative medical testimony" before courts is not only ludicrous but constitutes a prostitution of good medicine. Caution and good faith deter the good physician or surgeon from participating in court work when he is not on familiar footing. Consequently, testimony with respect to occupational diseases too often is of a low order—emanating from the mouths of so-called "experts," who, in fact, are illy qualified to present facts.

Recently, during the life of a patient, who subsequently died, a consultant made a diagnosis of "chronic benzine poisoning." The family physician, being less versed in occupational diseases than in alkaloidal poisoning, without evil intent, made his many court reports to read "chronic brucine poisoning." It is quite unlikely that the victim ever saw any brucine, yet the financial integrity of this dead man's dependents was jeopardized by this physician's act.

Not long ago I heard a reputable surgeon testify in a court, dealing with an occupational disease claim, that dusts entering the lungs exert a beneficent action. Dusts, it was affirmed, by their gentle irritation of the respiratory tract, serve to tone the tissues against infection. The *Journal of the American Medical Association* recently published a court decision in which lead poisoning (in Idaho) was adjudged to be an accident and not an occupational disease, because the period of exposure was only 5 weeks, and thus too short a time to produce an occupational dis-

ease. Behind this travesty, and I trust this remark constitutes no contempt of court, undoubtedly lies the testimony of some one or more physicians.

Failure to accept responsibility for occupational disease is hurtful to the status of the entire medical profession. Failure to delve into the precise activities of a worker who has become a patient frequently paves the way for much social injustice and medical inaccuracy.

In 1700, Ramazzini, the forefather of occupational disease work, in his *Diseases of Artificers and Tradesmen*, soundly observed in the preface, that every physician should not only ask his patient—"... what uneasiness he is under, how many days he has been ill, how his belly stands, what food he eats, ..." but also "... *what trade is he of?*" If that interrogation was important two hundred years ago, how much more needful is it today! Moreover, it is not sufficient to ask, "What trade is he of"; for in our day most trades are highly subdivided. In Ramazzini's time it was sufficient to establish that a worker was a shoemaker, but today the shoemaker's work is divided into three hundred operations, from archers to welt makers, each with its particular degree of danger for the exposed workman.

Whether or not the physician wills it, he is faced with the fact that occupational diseases are real, numerous, severe, and costly. So clearly do they fall within the field of the practice of medicine that they may not be ignored. During the work decades of life, second only to infection, occupation is the most potent cause of incapacity!

THE CARE OF EMPLOYEES IN INDUSTRY BY PHYSICIANS AND SURGEONS IN INDEPENDENT PRACTICE

FREDERICK W. SLOBE, M.D., CHICAGO

THE scope of this paper concerns the care of employees in industry by physicians who are not engaged in a full time capacity with one corporation. As the companies with which such physicians deal are usually small, a physician may have connections with a few or with a great many corporations depending upon their size and the percentage of the physician's practice which is industrial in type.

About 99 per cent of the corporations in this country employ less than 1,000 men, and in this 99 per cent are employed about 30,000,000 men and women. Of this vast number of employees, perhaps 80 per cent are employed by corporations which do not have full time physicians, hence are given industrial care by doctors in independent practice. These figures furnish ample evidence of the importance of this subject. They should focus the attention of every physician who elects to treat the industrially disabled upon the obligation attached thereto; likewise, they should impress all medical organizations and physicians who, though not interested individually in industrial care, should be responsive to the duties of the medical profession in this rapidly growing field of endeavor.

In the industrial centers where corporation practice is more standardized, private and industrial practice are not readily miscible, so physicians who, having a liking for corporation practice or for traumatic surgery and whose industrial contacts show gradual enlargement, soon find themselves practically full time in their field of endeavor, even though not full time with any one corporation. The special fields of traumatic surgery and of industrial medicine (whether considered separately or linked together) are of such scope as to merit the fullest recognition by the medical profession and the public. This recognition is vital if these specialties are to keep pace with the increasing demands made upon them.

In this industrial medical evolution some physicians, inclined toward the medical side of practice have emerged as specialists in industrial medicine and hygiene; others, surgically bent, prefer to be known as specialists in traumatic surgery. In both instances conducting a concurrent private practice is usually precluded. It is fitting, therefore, that those qualified receive recognition as specialists in their field and that such recognition be based on ability and not on the mere fact that a physician is confining his major activities to industrial practice. This process of selective recognition will attract young physicians of higher caliber to this field which will redound to the benefit of the employees in industry.

A physician dealing with many widely diversified industries has the opportunity of developing a breadth of outlook and a wealth of experience which is obtainable with much greater difficulty by a physician spending his entire time with one corporation unless that corporation is extremely large. At the same time he is subject to the disadvantage of not having sufficient intimacy of contact with any one company to enable him to fulfill many of the requirements of a complete industrial service.

Fundamentally, all employees are entitled to the same standard of medical supervision and service irrespective of the size of the company and regardless of whether a full time physician is in charge or a part time doctor in independent practice. Assuming this inherent right of the employees what are the essentials of factory medical service?

Briefly, the duties which a plant physician should be called upon to perform are the following: the care of those injuries, diseases, and abnormal conditions covered by the compensation law; the rehabilitation of the industrially disabled; conducting pre-employment medical examinations and periodical re-examinations during employment; the eradication of accident and health hazards; the prevention of the spread of communicable diseases in the plant; the regulation of factory hygiene and sanitation; co-operation with the employment manager in the selection of jobs to fit the physical and mental status of the individual; the supervision of physical defects and ailments not caused by employment in order to maintain efficiency and prevent loss of time; general health instruction to the factory personnel; and finally, the maintenance of a friendly contact with the employees' family physicians. In this latter connection it is understood that the domain of the family doctor is not invaded. On the contrary, the insistence of the plant physician will send many patients to their own doctors for the correction of physical defects or the care of bodily ailments, often unrecognized previously.

Now, if we scrutinize the foregoing duties of the plant physician how many of them do we find performed in the average instance? Unfortunately in most cases we find the physician's contact with a factory practically limited to the care of accidents and diseases for which the employer is legally responsible. Are the physicians so negligent in their realization of the potential possibilities of an adequate industrial service or are there other fundamental factors at fault? Much has been said about the ineffectiveness of physicians in dealing with industrial problems—and there is no denying there is some justification for this criticism—but far too little has been said concerning the backwardness of corporations in recognizing the necessity for a complete medical service. It can be stated with confidence that practically every physician in independent practice would be only too glad to comply, in so far as he is able, with any request made by any company for some service in addition to the routine care of the injured. But such requests are so seldom forthcoming as definitely to damper any enthusiasm with which the physician might be imbued to enlarge the scope of his affiliation with the factory. This apathy of the smaller corporations is exceedingly deterrent in frustrating the right of their employees to receive the same degree of general medical supervision obtained by those employed by larger corporations having full time physicians.

Our profession should aid in sponsoring an intensive educational campaign to apprise the heads of corporations with the dividends which an adequate medical service pays. Likewise, the matter should be brought before the labor organizations and before the public. If industry makes the demand, surely the medical profession will meet it, just as it almost invariably has met other demands in the past. Physicians doing a small amount of corporation practice, who might not be ideally prepared to meet these new phases of industrial service either would have to equip themselves mentally to meet the new conditions or else risk losing whatever corporation contacts they might have acquired. Education of the profession, while essential, will be futile in solving the problem unless corporation consciousness is concurrently awakened.

The apathy displayed by most corporations toward their medical service is almost incomprehensible. The average factory superintendent, engrossed in his study of production costs, pays little heed to the care of his sick and injured, seemingly oblivious to the vital, though somewhat intangible, rôle the welfare of his workers plays in his balance sheets. Before relegating the care of his employees to a certain physician, the head of a factory should investigate that physician's qualifications with the same degree of care exercised in the selection of a physician for his own family.

Another factor in causing this disinterest of the employer arises directly out of the placing of compensation insurance. After receiving insurance coverage, the employer only too frequently selects any conveniently located doctor, or accepts without question the physician designated by the insurance carrier. Having paid his insurance premium he is disinclined to expend further funds, feeling that he has met the requirements of the compensation law and that the burden now rests with the insurance company. The insurance carrier quite naturally is concerned only with fulfilling the requirements of the policy in force and thus all the employee receives is minimal service. It is obviously impractical for most corporations to be self-insurers but if they were they would be far more analytical and critical in their selection of medical service than they are now.

A similar situation exists in connection with pre-employment examinations, the great value of which is appreciated by all physicians doing industrial practice, but is absolutely unappreciated by the vast majority of the smaller corporations. Such examinations are not inimical to the workmen, any criticism from their standpoint being more than offset by the early detection of unrecognized physical defects and ailments. Any overtures in this connection made by the plant physician are likely to be viewed askance by the company officials, both on account of the cost and because they are likely to feel the physician is merely trying to increase his own revenue. Were such examinations made legally compulsory both the employer and employee—and that means industry as a whole—would benefit.

Though perhaps apparently irrelevant to this subject the custom of carrying compensation insurance actually has a very decided effect on the relationship between the factory and the physician in independent practice. As such insurance coverage is and doubtless will continue to be an almost universal procedure a study of remedial measures would be timely. For example, if the workmen's compensation laws contained provisions covering the needed additions to the present limited medical service, the situation would be clarified greatly. This would necessitate either corresponding changes in insurance policies to include the additional coverage or, better still, would legally force the employer to assume these new responsibilities independent of the insurance carrier. This should

eventually bring him to a realization of the value of the measures involved.

At first thought this might appear to throw an additional burden on the employer. Even if it were a burden it would be justified by the existing need but actually any increased initial cost would be amply repaid by increased industrial efficiency yielding dividends which, though somewhat intangible, would be none the less real.

And the physician when treating a patient afflicted with an occupational disease or injury should not focus his attention exclusively on the affected part but give thought to that individual as a whole; further, he should be cognizant of the fact that that individual is an integral part of an industrial organization; and still further, he should bear in mind that the same individual is a definite part of a social order.

METHODS OF EVALUATING EXTENT OF INJURIES

EARL D. McBRIDE, M.D., F.A.C.S., Oklahoma City, Oklahoma

PHYSICAL disability means a limitation of normal use of the body or parts of the body. In industry, physical injury brings about anatomical and physiological changes which alter the earning capacity and for which society attempts to compensate the individual. The physician, because of his knowledge of the human organism, is called on to analyze and measure the newly acquired limitations. Difficulties arise, however, when he attempts to evaluate the clinical evidence of physical disability in terms of loss of working capacity. There seems to be no suitable measuring rod as yet devised; no definite basis of reasoning; no common ground upon which conclusions and opinions may rest. From the medical standpoint there is no reason why the extent of disability and its evaluation should not be diagnosed through just as logical and systematic manner of reasoning as is employed in diagnosing disease.

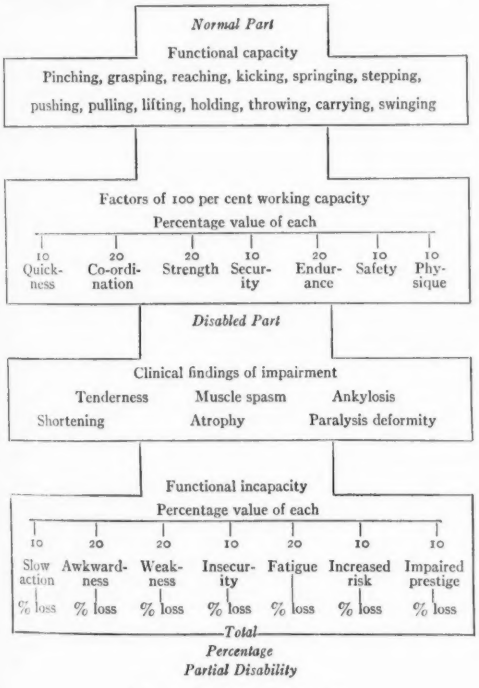


Fig. 1. Basis of evaluation

Most compensation laws base the extent of disability award on anatomical loss rather than on functional incapacity. Amputations at certain points, for instance, have specific awards. If only partial loss has occurred, however, the award can be determined only by apportioning whatever extent the percentage of partial loss approaches the total loss anatomically. That is, if the part is not entirely lost, of what value is it, compared to total loss? At this point the question ceases to be simply one of anatomical deficiency. The lost value of the part no longer can be estimated by its altered shape, size, or motion. It must be measured by establishing the amount of use the part will be to the individual since the changes in shape, size, losses of motion, or other alterations have taken place. It is within the scope of medical science therefore to determine the loss of function, thereby formulating an opinion, expressing the extent of loss.

The extent of evaluation is usually asked for in terms of percentage. A convenient measuring rod, therefore, would have a scale of one hundred units of working capacity. The various factors which constitute normal function for working capacity can be given an estimate of importance by establishing their percentage value on the scale of one

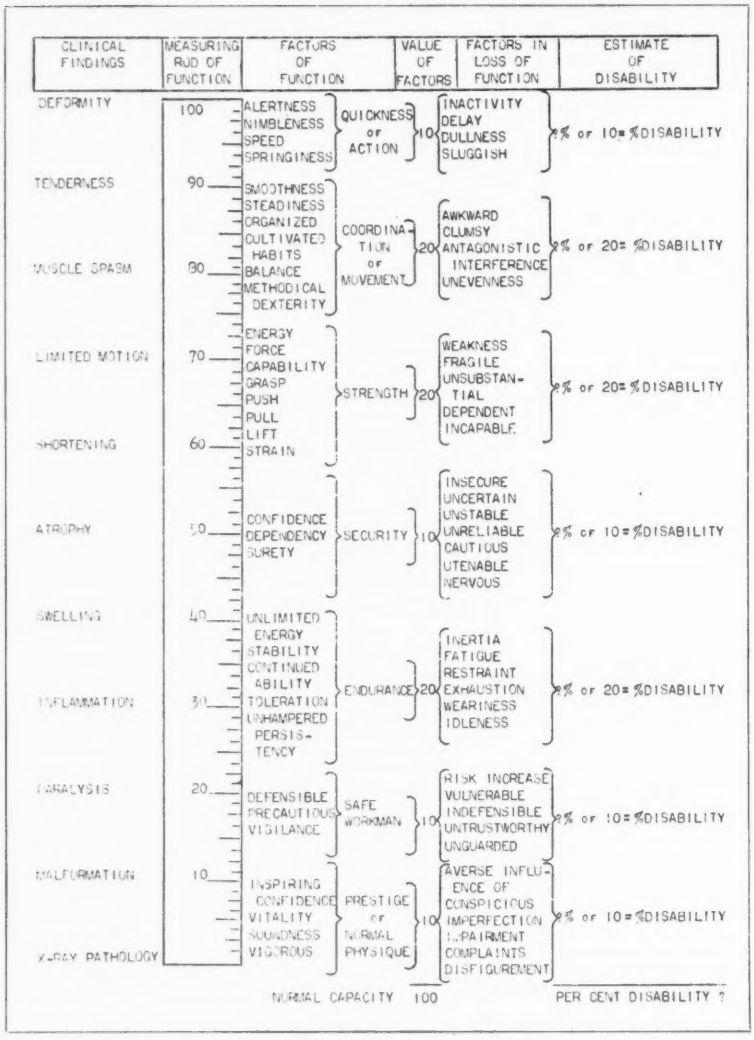


Fig. 2. Evaluation of extent of disability.

hundred per cent measuring rod. Their total then would be one hundred per cent. An analysis of the functions of the body from the working capacity standpoint, would seem to be amply expressed in five principal factors, which make possible such acts as grasping, throwing, jerking, pulling, pushing, turning, bending, lifting, walking, jumping, and running. These factors are:

1. *Quickness of action*, indicating alertness, nimbleness, and speed.

2. *Co-ordination* of movements, indicating smoothness of action, steadiness, dexterity or a synchronizing of movements resulting in proficiency, deftness and good control.

3. *Strength*, indicating physical energy, force of intensity, power of action as well as muscular ability.

4. *Security*, indicating confidence, habitual trustworthiness and reliability without conscious effort.

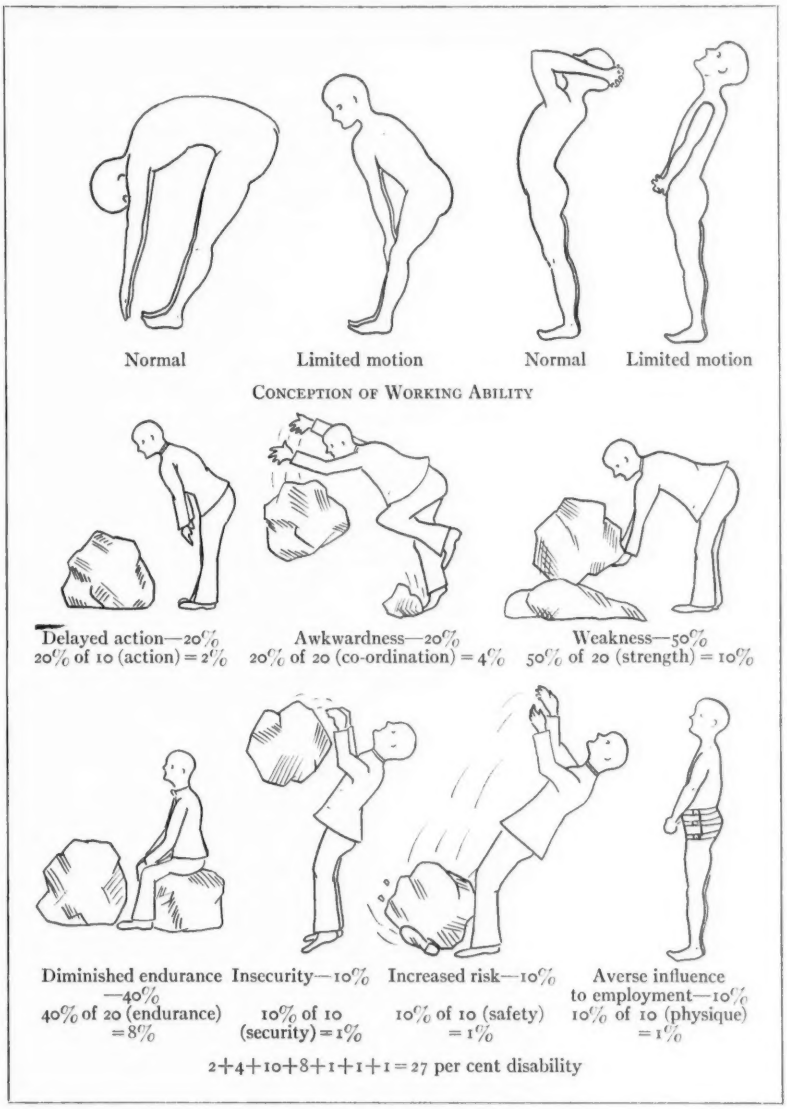
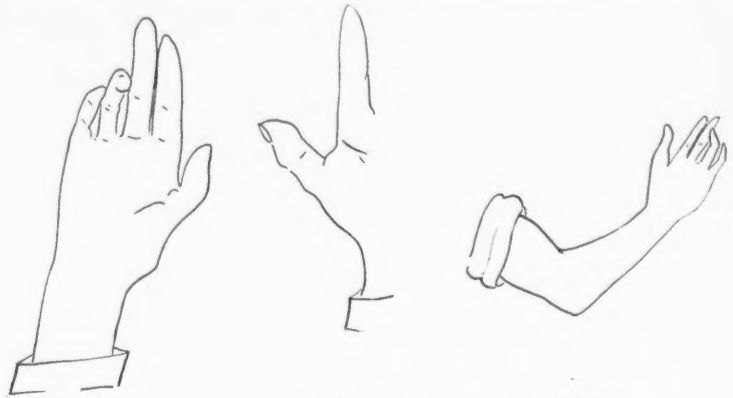


Fig. 3. Evaluating a back disability.

Motion limited from full extension to 95° flexion

Conception of working ability		Estimate of disability	
Delayed action	25 per cent	25% of 10 (value quick motion)	= 2.5
Awkwardness	25 per cent	25% of 20 (value co-ordination)	= 5.
Weakness	15 per cent	15% of 20 (value strength)	= 3.
Insecurity	15 per cent	15% of 10 (value security)	= 1.5
Diminished endurance	15 per cent	15% of 20 (value endurance)	= 3.
Increased risk	10 per cent	10% of 10 (value of safety)	= 1.
Averse influence to employment	15 per cent	15% of 10 (value of physique)	= 1.5
		Percentage disability to arm	= 17.5

Fig. 4. Disability of arm.



Ulnar nerve paralysis causing loss to arm of 60%

Ankylosis of thumb causing loss to arm of 10%

Ankylosis of elbow causing loss to arm of 50%

60+10+50 would be 120 per cent

Loss cannot be over 100 per cent

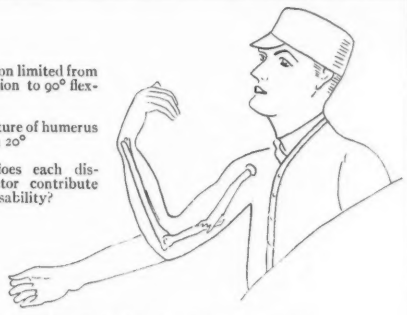
Proper way to figure multiple losses of 100% arm:

100%—60 leaves 40 per cent; balance good arm
10% of 40 is 4 per cent loss credited to thumb disability
40%—4 leaves 36 per cent; balance good arm
50% of 36 is 18 per cent loss credited to elbow disability

Therefore 60% (nerve loss)+4% thumb loss+18% elbow loss=82%

Total loss to arm=82%

Fig. 5. Multiple severe disabilities to same arm.



1. Motion limited from full extension to 90° flexion

2. Fracture of humerus angulation 20°

What does each disabling factor contribute to total disability?

Estimated loss from limitation of motion = 17.5 per cent.

Estimate of evaluation from fractured humerus:

Conception of working ability		Estimate of disability	
Delayed action	0 per cent	0% of 10 (value quick motion)	=0.
Awkwardness	5 per cent	5% of 20 (value co-ordination)	=1.
Weakness	10 per cent	10% of 20 (value strength)	=2.
Insecurity	5 per cent	5% of 10 (value security)	=0.5
Diminished endurance	5 per cent	5% of 20 (value endurance)	=1.
Lowered safety	0 per cent	0% of 10 (value safety)	=0.
Averse influence to employment	5 per cent	5% of 10 (value physique)	=0.5
		Percentage disability to arm	=5.

Not mathematically proper to add these two disability amounts to obtain total percentage. Proper method is to deduct one loss and estimate per cent loss of balance.

100 per cent, less 17.5 per cent due to limited motion.. =82.5
5% (fracture loss) of 82.5 (balance good arm)..... = 4.12 per cent
17.5 per cent plus 4.12 per cent..... =21.62 per cent disability

Fig. 6. Multiple disability to arm.

5. *Endurance*, indicating toleration, vigor, and continuation of activity without interruption.

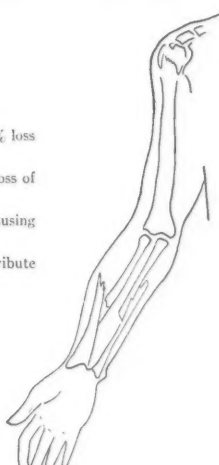
In respect to industrial injuries, two other factors may be placed on the scale:

1. *Safety*, indicating ability to protect oneself and others.

2. *Prestige*, of normal physique and apparent competency in seeking or retaining employment.

These functional factors may be applied to specific parts of the body. In the hand they would be stated as follows: (1) quickness and nimbleness of digital action; (2) co-ordination of fingers and thumb in apposing finger tips to thumb, and thumb to fingers and palm; (3) strength of grip and fist making ability, striking, slapping, holding and pushing power; (4) security or reliability of delicate finger sense, and dependability on life long habitual and technical finger accomplishments; (5) endurance of pinching, holding, or gripping action.

In respect to the leg, foot and toes, the factors may be considered as follows: (1) quickness, nimbleness, springiness of step and gait; (2) co-ordination of feet and toes in smoothness and steadiness of step and gait; (3) strength of weight bearing and power of action in standing, walking, running, or jumping; (4) security or reliability of toe, heel or foot action in habitual and technical accomplishments of life long development; (5) endurance of gripping power of toes; toleration of continuous action.



1. Contraction causing 25% loss of index finger

2. Fracture causing 50% loss of hand

3. Ankylosed shoulder causing 50% loss of arm

How much does each contribute to loss of entire arm?

All disabilities must be reduced to terms of loss of arm
Law may allow 35 weeks for loss of index finger
Law may allow 200 weeks for loss of hand
Law may allow 250 weeks for loss of arm

To find per cent finger is to arm—
Divide 35 by 250 and result is 14%

To find per cent hand is to arm—
Divide 200 by 250 and result is 80%

To estimate loss of finger in terms of loss to arm—
25% loss of finger is 25% of 14 or 3.5% loss of arm
50% loss of hand is 50% of 80 or 40% loss of arm

On basis of percentage method; to determine total loss—
100—3.5 (finger loss evaluation) leaves 96.5% good arm
40% (hand loss evaluation) of 96.5 = 38.6 loss credited to hand
96.5—38.6 = 57.9 balance good arm
50% (shoulder loss) of 57.9 = 28.9% loss to arm at shoulder

Therefore 3.5+38.6+28.9 = 71% loss of arm

Fig. 7. Disability to parts of arm each having specific award.

The method is graphically presented in Figures 1 and 2.

The scale of the rule is graded as follows:

Quickness of action	value 10 per cent
Co-ordination of movements	value 20 per cent
Strength	value 20 per cent
Security	value 10 per cent
Endurance	value 20 per cent
Safety factor	value 10 per cent
Prestige of normal physique	value 10 per cent
Total	100 per cent

In making an estimate of the extent of disability the percentage of loss of each functional factor is conceived from the standpoint of medical knowledge and the result is expressed in terms of disability.

For instance, if it is thought the activity factor will be affected 25 per cent, then 25 per cent of 10, the value of the factor, means 2.5 per cent disability. Applying the test to each of the factors in the 100 per cent scale on the so-called measuring rod of function and summing up the percentage of loss of each factor, the total amount of disability is determined. For example, a back disability might be conceived as illustrated in Figure 3.

If a disability to an arm has occurred, such as a limitation of motion at the elbow, the same principles, on the measuring rod, are applied. For example, an estimate might be applied as in Figure 4.

Multiple disabilities often are very troublesome in that the physician may be asked what percentage each contributes to a disability. These may be estimated as illustrated in Figure 4.

Another troublesome phase of estimating disability is that in which each individual disability to a part is so great that the sum of all disability percentages would be more than 100 per cent. The methods of calculating such a case is illustrated in Figure 6.

In many States the law awards a certain amount for loss of individual parts of the body such as a finger, hand, arm or foot. Where a disability has occurred to several parts of an extremity, as in the finger, hand, and upper arm, it is sometimes rather difficult to express in proper percentage the disability each part is to the entire arm. The method of estimating such disabilities is illustrated in Figure 7.

TRIVIAL INDUSTRIAL INJURIES OF THE HAND LEADING TO PROLONGED DISABILITY

ALLEN B. KANAVEL, M.D., CHICAGO

IT is unfortunate that many patients with trivial injuries do not apply at once to their physician for proper treatment. Too often the surgeon sees patients who have sustained simple injuries of the hand which if they had been treated promptly and properly would have given rise to no disability or trouble. Many patients who now have useless hands would have been spared this disability had small pin and needle punctures, scratches, and bruises been properly treated, if such injuries had been properly cleansed and treated with antiseptics and kept clean.

Among these, attention may be drawn to infection from cattle hairs. These occur most commonly in those dealing with cattle, such as stockmen, those milking cows, etc. The hairs of cattle have scales that tend to migrate under the skin when they have entered through some cracked callus. These patients develop minor abscesses which, if opened, heal to be followed by repeated abscesses and disability often extending over a period of months. If the abscesses are properly opened and all the migrating hair removed there is prompt recovery.

Another minor injury almost always neglected is that due to indelible pencils; for example, an office worker breaks off the point of an indelible pencil in the palm, the point remaining in the tissue. At times nothing is done, and at other times inadequate attempts are made at removal, with the result that the indelible lead is crushed. After this, although no difficulty may be experienced for several days, chemical action of the dye may take place and cause the death of the tissues around the pencil point puncture and infection may ensue. Such patients may have serious disability lasting for weeks and months and suffer great pain and discomfort. If a surgeon had been consulted he would have removed at once and completely the destructive indelible point. In the public schools in Germany indelible pencils are now forbidden to children, to safeguard them against the loss of eyes from injury of the conjunctiva from such pencils.

THE PROBLEM OF COMPETITION IN INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

H. J. WHITACRE, M.D., TACOMA, WASHINGTON

THE time-honored and highly commendable ambition of every educated physician to develop a practice upon a basis of his opportunity to use his assets in service to society has been seriously thwarted in the state of Washington. This has been brought about by that form of health insurance known as contract practice.

Industrial accident insurance was first established in Washington to make it possible to render proper medical and surgical service to the workers in remote lumbering camps. Later, this plan for paying for such service was adopted in cities and towns. Contract practice likewise followed this plan into the urban communities with the result that in the concentration of such surgery in the hands of a few physicians who seek these contracts, the methods of securing this work are not always within the bounds of fair and ethical competition.

The medical profession did not resent industrial insurance or contract practice seriously as long as contracts were confined to industry and large groups of workmen. The object is to the employment of lay solicitors to comb the community, extol their employers, and sign up small groups in all walks of life. One such contracting physician is operating this system over a radius of 30 miles and this area includes large cities.

A commendable and necessary method of rendering medical care in remote industrial regions has been transformed by commercial methods into a gigantic health insurance movement that threatens to include the entire population, and the general medical profession is very properly alarmed.

Some have advocated the expulsion of contract doctors from our medical societies. Others have urged the passage of laws forbidding contract practice. Neither position is tenable.

Counter movements initiated by groups in medical societies have not always been successful for obvious reasons.

Eighteen months ago the physicians of Tacoma established a research laboratory for the study of medical economics, and industrial medicine in its relationship to the general problem of state health insurance has been the major problem studied.

Contract practice is legal in the State of Washington.

Organized labor is opposed to contract practice, and most of our physicians, even those who hold contracts, do not like this method of practicing medicine; but both the preference of employers for this system, and the need of industry for some form of accident and health insurance have woven it firmly into the industrial fabric of the State of Washington. We must deal with it. We are not opposed to health insurance as a principle.

We are opposed to the evils which have crept in as the details of the system have been applied and believe that the medical profession should furnish the leadership for a movement to develop a better form.

The Tacoma group have done some intensive work on a plan for handling the situation in Tacoma. The causes of failure in other groups have been largely professional shortcomings and the entire group has now agreed to submit to rigid rules and regulations for their elimination.

We have tightened control by giving autocratic power to a committee of three. Each new case must be promptly reported to the office of the bureau, a case record must be set up, and the executive committee must review the file daily. This committee has the authority to call a consultation on any serious or prolonged case, and the consultant must file a written report of the consultation at the bureau office. Bills may be modified or disallowed. State and insurance reports are sent through the bureau office and it is the duty of the manager to see that they are promptly and properly completed. The bureau, or in other words, the organized profession, stands behind the quality of service rendered.

An experiment in a department store has shown that one dollar per month per person is not sufficient to render adequate medical service. The amount necessary is from one dollar and fifty cents to two dollars per month.

On the whole, the plan of the Tacoma group is working well under the strict regulations.

CONFERENCE ON TEACHING OF SURGERY

GRADUATE AND UNDERGRADUATE TEACHING

THE personnel of the Committee on the Teaching of Surgery and Surgical Specialties is as follows: Fred C. Zapffe, Chicago, chairman; Elliott C. Cutler, Cleveland; Irving S. Cutter, Chicago; George J. Heuer, New York; Alexander R. Munroe, Edmonton; Allen O. Whipple, New York. The conference on this subject was held at the Jefferson Hotel, St. Louis, October 19, 1932, as a part of the Clinical Congress of the American College of Surgeons. Dr. C. Gordon Heyd, New York, vice-president of the American College of Surgeons, presided.

FRANKLIN H. MARTIN, director general of the American College of Surgeons, explained the reasons for the active interest of the College in the subject of teaching of surgery and the surgical specialties in the following terms:

Why does the American College of Surgeons seek co-operation with the Association of American Medical Colleges? Because it is a paramount aim of the American College of Surgeons to improve surgery that is necessary and to eliminate unnecessary surgery. If this program is to achieve its greatest development, the American College of Surgeons must have an interest in every branch of medicine; it must co-operate with the approved medical schools where medicine is taught; it must co-operate with the approved hospitals, the environment in which doctors and surgeons treat the ill and injured; it must co-operate with the scientific development of general, special, and applied science; and it must co-operate with the public on the basis of the ideals and ethics of the most learned profession.

There are in the United States about 145,000 registered scientific physicians. Approximately one-fourth of this number are engaged in public health activities, and another one-fourth have retired and are not now engaged in the active, independent practice of medicine. This leaves a total of some 75,000 doctors who are practicing independent preventive and curative medicine in *personal health*. It is therefore apparent that the American College of Surgeons—consisting of 10,849 practicing surgeons joined in a strong administrative corporation—is in a position to co-operate closely with your influential body that is so deeply interested in the guidance of the teaching of all branches of medicine and surgery.

Particularly are we interested that the scientific medical profession shall maintain the purity of its ranks; that it shall be kept free from the encroachments of irregulars, cultists, and patent medicine vendors.

We are anxious that medical graduates who are serving as internes in our hospitals shall be protected from the subtleties of politics and irregular associations; that any hospital shall be ineligible for interne assignments if it is loose in its ethics; if it tolerates irregular financial practices among its medical staff; if the staff conferences are neglected or actually repudiated and ignored; and if indifferent records and perfunctory laboratory reports are countenanced.

The College has worked conscientiously to eliminate these irregularities from hospital conduct. Each year the approved list of hospitals embodies such institutions as are found eligible after careful personal survey by a representative of the College. This list is in your hands. The dean of every Class A medical school possesses that record, and he can readily ascertain from us why any particular hospital is not on that list. If we can be shown that we have erred in our judgment in eliminating a hospital, we will be glad to make amends.

The paramount object of this yearly conference is to encourage a discussion of our mutual activities, and to lend the sympathetic influence and co-operation of the American College of Surgeons to the word of your Board, and to the medical schools which have the responsibility of educating the doctors of the future.

FRED C. ZAPFFE as chairman of the Committee spoke of the formation of the Committee and its purposes and stated that the Committee wished to secure the opinions of all teachers of surgery and to present them in a report which will be helpful to teachers of surgery in rebuilding their courses.

GEORGE J. HEUER'S paper on "Graduate Teaching of Surgery" was presented, in his absence, by Dr. Zapffe. Dr. Heuer expressed the opinion that the opportunities for graduate instruction in surgery in this country are inadequate and that they could and should be increased; not only in the medical schools but possibly in the larger and more important hospitals. Dr. Heuer had sent out a questionnaire and analyzed the type of graduate teaching in 24 medical schools. In these schools graduate teaching in surgery takes the form of resident or fellowship systems, with a variable time in continuous residence in a teaching hospital where the experience includes surgical pathology, surgical diagnosis, preoperative and postoperative course of surgical patients and a variable amount of operative experience gained at first as an assistant, then as an operator under supervision, and finally as an independent surgeon. These courses of instruction vary from 1

to 5 years and are not uniform in amount of time devoted to the various subjects or in the subjects covered. A number of the schools giving such courses grant degrees upon their satisfactory completion. Of the men who have taken such courses the majority have positions of professional or other rank in the country. The favorable opinion of the heads of the departments of surgery in certain medical schools toward such a course of instruction was expressed.

ELLIOTT C. CUTLER's paper on "Undergraduate Teaching of Surgery" was presented by Dr. Zapffe. As a result of the questionnaire sent to leading surgeons teaching surgery in the United States the trend of opinion was expressed as being that these surgeons emphasized the type of the principles of surgery, surgical pathology, a course of minor trauma and sepsis and surgical diagnosis. These same men have indicated strongly that they do not think it within their province to teach operative surgery. Dr. Cutler emphasized the desirability of realization on the part of the medical schools and licensing boards for the necessity of an extra and special training before medical graduates are allowed to assume responsibilities attendant upon the individual practice of surgery.

ALLEN O. WHIPPLE presented his paper on "Post-Graduate Instruction in Surgery." Dr. Whipple stated that the successful development in the organization of adequate and modern medical service in any community depends upon the training, the ability, and the experience of the professional personnel. The proper allottment of time and the graded sequence of the periods of training required in the various fields of medicine and the specialties are the factors which have to be considered in the pre-medical school, medical school, hospital interneship, residentship or fellowship up to, and including, post-graduate courses for those already trained in general medicine or the specialties. These are but phases of the entire scheme of medical and surgical training. Dr. Whipple emphasized the fact that post-graduate courses in surgery and surgical specialties should be limited to candidates with adequate surgical training and with some experience in surgical practice. Such courses should be properly organized and conducted by senior and more experienced surgeons preferably under university auspices. In such courses the advantages were pointed out of diagnostic clinics, follow-up clinics, laboratory courses, courses in roentgen film and fluoroscopic interpretation, courses in endoscopy, and experience gained by close association with the teaching surgeons.

ALEXANDER R. MUNROE presented the "Amendment to the Medical Profession Act of the Province of Alberta of 1926," which prescribes qualifications for those who practice surgery in that Province. The qualifications are fulfilled under the auspices of the Senate of the Provincial University. During the past 6 years, 83 certificates in general surgery and surgical specialties have been granted.

The discussion of these subjects was continued by Drs. Howard C. Naffziger, Samuel C. Harvey, Owen H. Wangensteen, George W. Crile, and W. T. Coughlin. Dr. Harvey drew attention to the necessity of producing men with initiative enough to go on learning surgery the rest of their lives and to the fact that to accomplish this a modern system of apprentice assistants would be a desirable method. Dr. Wangensteen expressed the opinion that so many already trained surgeons are now generally available that the minimal requirements of training for the practice of surgery should be clearly defined and he emphasized the importance in surgical training of experience in other than operative procedures. Dr. Crile explained that all of the activities of the American College of Surgeons are part of a great educational program and indicated that it was fitting that such an institution display a great interest in the facilities available for the training of surgeons and surgical specialists.

COMMITTEE AND DEPARTMENT REPORTS

DEPARTMENT OF CLINICAL RESEARCH—ALBERT J. OCHSNER MEMORIAL

THE work in clinical research, which is being conducted by the College, includes that of the following committees: committee on the treatment of malignant diseases; committee on the archives of malignant diseases; committee on bone sarcoma; committee on the treatment of fractures; committee on clinical laboratories; board on medical motion pictures; board on industrial medicine and traumatic surgery.

A survey of the work of this department which has been performed during the past year is embraced in the reports of the individual committees.

COMMITTEE ON THE TREATMENT OF MALIGNANT DISEASES

ROBERT B. GREENOUGH, M.D., BOSTON, Chairman

I HAVE the honor to submit the following report of the Committee on the Treatment of Malignant Diseases.

The subject of cancer clinics has been actively promulgated during the past year by personal interviews with the administrators and medical staffs of hospitals. For this purpose the Director General has assigned the co-operation of the hospital investigators and in addition two special field representatives.

It is obvious that there are hospitals on the approved list of the College in which it would be inappropriate to have cancer clinics, such as in many of the hospitals of the federal government, in the hospitals for children, and in maternity, orthopedic, tuberculosis, mental, convalescent, contagious diseases, industrial, and eye, ear, nose and throat hospitals. But in every hospital into which cancer cases are received there should be facilities and personnel for efficient diagnostic and therapeutic measures, and this implies consultations or conferences between trained surgeons, radiologists, and pathologists.

In some hospitals it happens that there is one individual member of the staff or one department whose special interest in cancer has led to an unusually good organization for the care and follow-up of cancer cases in that department. Such hospitals are recognized in the listing of the College by a special designation referring to the departmentalization of the hospital and the existence in one or more of the departments of the equivalent of the minimum standard for cancer clinics.

From other hospitals or clinics evidence has been presented to the College that the required facilities and personnel are available but that completion of the organization of a formal clinic along the lines recommended by the College has not yet been accomplished. Such institutions will have appropriate recognition in the listing of the College.

In certain clinics in medical schools, and in certain rural hospitals, the function of the cancer clinic is restricted to that of providing diagnoses, whereas the therapeutic measures are carried out in completely equipped institutions to which the patients may be referred. Such diagnostic clinics should attain appropriate standards and will receive recognition in the listing of the College.

It is proposed that a list of approved cancer clinics be published in 1933. The hospitals that have been personally surveyed or from which adequate reports have been received during the past year number one thousand fifteen. Of these seven hundred two have no cancer clinics. A tentative classification of the cancer clinics follows:

Approved	100
Recommended	58
Organizing or contemplated	155

At the meeting of the Committee one year ago eleven additional record forms for cancer of different parts of the body were approved and extensive circulation has been given to these record forms which now number sixteen. During the year two new record forms have been prepared and others are in the course of preparation. The widespread adoption of these forms will do much to facilitate the compilation of reliable statistics on the subject of cancer in America.

In continuance of the previous work of the Committee, all Fellows of the College and Members of the Radiological Society of North America were invited during the month of May to register with the Committee all cases of cancer occurring in

their practice during the years 1924–25–26. As a direct response to this request there have been received thus far 2,365 detailed records of cancer of different parts of the body, included among which are 1,020 of 5 year survivals. These records are being subjected to careful analysis for grouping as to organs, types of cancer, methods of treatment and results, and the information will be tabulated and published with the three thousand detailed records previously in the archives of the Committee.

The recency of any general movement for the organization of formal cancer clinics and their more accurate records has impeded the work of the Committee in the collection of statistics of greater volume.

An important result of this widespread request and the distribution of record forms has been the known installation of improved record systems by many hospitals, so that, in the future, compilation of results will be much facilitated. Many who signified their willingness to co-operate in this study found it impossible on account of incompleteness of their existing records, and have now installed new record systems.

The College engages in these cumulative studies for the benefit of its Fellows and of humanity, and it will accomplish its purpose only when its Fellowship in its entirety approves and participates in such studies. These studies by the committees and by the administrative officers constitute merely a means of expressing the voice and work of the Fellowship of the College. On the other hand it is the duty of the committees and the administrative branch of the College to indicate to its Fellows methods and studies that will lead to progress in knowledge and in its application. In no small degree this purpose has been accomplished by the inauguration of the work directed toward the compilation of reliable statistics.

In addition to this work more attention has been directed toward the compilation of cumulative statistics from authenticated recent reports in the literature. Based on a study of this literature which has been compiled by the College, Dr. Grantley W. Taylor prepared an article on "Cancer of the Breast," which was published by the College. Similar publications on cancer of other organs are contemplated.

Minimum Standard for Cancer Clinics in General Hospitals

1. *Organization.* There shall be a definite organization of the service, and it shall include an executive officer and representatives of all the departments of the hospital which are concerned in the diagnosis and treatment of cancer. The services of a secretary and of a social service worker shall be available.
2. *Conferences.* As an essential feature of the service there shall be regular conferences or consultations at which the diagnosis and treatment of the individual cases are discussed by all members of the clinic who are concerned with the case.
3. *Patients.* Reference to the cancer clinic of all patients in whom the diagnosis or treatment of cancer is to be considered shall be either voluntary or obligatory in accordance with the vote of the medical staff or of the governing board of the hospital.
4. *Equipment.* In addition to the diagnostic and therapeutic surgical equipment which is required in every approved general hospital there shall be available an apparatus for X-ray therapy of an effectiveness which is generally agreed upon as adequate, and an amount of radium sufficient to insure effective treatment.
5. *Records.* In addition to the records which are required in every approved general hospital, there shall be additional records of: (1) the details of the history and of the examination for cancer in different regions of the body, such as are indicated on the form records which are recommended by the Committee on the Treatment of Malignant Diseases, American College of Surgeons; (b) the details of the treatment by radium or X-ray as indicated on the form records which are recommended by the Committee on the Treatment of Malignant Diseases, American College of Surgeons; (c) periodic examinations at intervals for a period of at least five years following treatment.
6. *Treatment.* The treatment of cancer patients shall be entrusted to the members of the staff of the cancer clinic except in cases in which adequate treatment in accordance with the collective recommendation of the staff of the cancer clinic can be procured otherwise.

The personnel of the Committee on the Treatment of Malignant Diseases is as follows:

Robert B. Greenough, Boston, *Chairman*

A. C. Broders, Rochester, Minn.
Curtis F. Burnam, Baltimore
George W. Crile, Cleveland
Bowman C. Crowell, Chicago
William Duane, Boston
Edwin C. Ernst, St. Louis
Rupert H. Fike, Atlanta
John M. T. Finney, Baltimore
Burton J. Lee, New York
Frank W. Lynch, San Francisco
Robert T. Miller, Jr., Baltimore
Henry K. Pancoast, Philadelphia
H. Gideon Wells, Chicago
Francis C. Wood, New York

COMMITTEE ON THE TREATMENT OF FRACTURES

CHARLES L. SCUDDER, M.D., BOSTON, Chairman

I HAVE the honor to submit to the Board of Regents the ninth annual report of the Committee on the Treatment of Fractures. There are now 39 members of the General Committee.

The death of a former member of the committee, Dr. A. P. C. Ashhurst of Philadelphia, and the death of an active member, Dr. Nathaniel Allison of Chicago, are recorded.

A revised and amplified second edition of *An Outline of the Treatment of Fractures* has recently been published by the College. The cordial reception of the first edition of this *Outline* by the profession has more than warranted the time and expense spent in completing this second edition. To Dr. Roscoe Webb, of Minneapolis; Dr. Edwin Ryerson, of Chicago; and the director of the Department of Clinical Research, Dr. Bowman C. Crowell, the appreciation of this Committee is extended for their supervision and conduct of this second edition. The Committee hopes to keep this *Outline* abreast of any important advance in the treatment of fractures. New printings from time to time will be made. It is the desire of the Committee to keep those members of the American College of Surgeons who are especially interested in fracture treatment periodically informed of progress in this special department of surgery. Copies of this *Outline* may be had by addressing the American College of Surgeons, 40 East Erie Street, Chicago, Illinois.

Regional committees. It has been from the beginning and still is the policy of the General Committee to extend the influence of the College through the living personal contacts made by membership of surgeons interested in fractures in these regional groups. There are now twenty-eight such Regional Committees. We have, therefore, at present about three hundred men carrying the ideals of the College directly into their several committees. The Committee believes that an immediate formation of new committees should be undertaken. Each state should have one or more active regional groups. Many applications have been received from different parts of the country for the formation of these local committees.

Industry is demanding that which the Committee on the Treatment of Fractures is prepared to deliver. It is strongly urged that the Department of Clinical Research make an immediate response to this demand.

In order to facilitate the work of these regional groups the College will soon publish in mimeographed form the reported activities of all existing regional committees.

Sub-committees. Steel Bone Plates and Screws. Committee: Philip D. Wilson; W. O'Neill Sherman; Norman T. Kirk; Wm. L. Keller. On June 18, 1931, a general conference of representative manufacturers, distributors, and users of steel bone plates and screws adopted a commercial standard for this commodity. The industry here has since accepted and approved for promulgation by the Department of Commerce, through the Bureau of Standards, the commercial standard. The standard became effective for new production on November 16, 1931.

The general conference voted the establishment of a standing committee: Dr. P. D. Wilson, chairman, sub-committee, American College of Surgeons; Dr. J. F. Barry, Veteran's Administration; Dr. J. F. Cochrane, Kny-Scheerer Corporation; Captain E. J. Gow, Navy Department; Major N. T. Kirk, Walter Reed Hospital; Harvey R. Pierce, Harvey R. Pierce Company; Charles J. Pilling, Geo. P. Pilling & Sons Company; John M. Smith, American Hospital Association; F. W. Reynold, secretary, Bureau of Standards.

The normal interval for revision of the standard is set for one year. Acceptances of the standard established were received from associations, firms, hospitals, and surgeons, and from government departments. The door to progress remains open through the existence of the permanent committee.

The Sub-Committee on Medical Education: Wm. Darrach, Frederic J. Tees, Isidore Cohn, George A. Leland, Jr., and Clay Ray Murray. Most of the medical schools of the country have reduced the number of hours in their undergraduate curriculum. As a result, in many special fields of medical work, the undergraduate instruction has become of necessity limited very largely to a thorough understanding of general principles followed by an opportunity to apply these to individual cases under the direction of a teacher. As a result of this, it has become of increasing importance that those responsible for the undergraduate teaching of fractures should concentrate their efforts on formulation and explanation of broad general principles. To make up for the lack of undergraduate teaching it is of great importance that in each hospital at least one be made responsible for the careful training of an interne staff in this field. Moreover, the need for the establishment of opportunities for the practicing physician to refresh or increase his knowledge in the treatment of fractures has become much greater. It is therefore recommended that

1. Even greater stress be placed on instruction in the pathology of fractures, the process of repair, and the broad general fundamental principles of treatment.

2. Each hospital, whether it contains a special fracture service or not, appoint someone who shall be responsible for the training of internes in the treatment of fractures.

3. Wherever possible opportunities for continued education for graduates in medicine be established

both in teaching hospitals and under the auspices of the various medical societies.

The sub-committee reported in detail the methods in use at Columbia University in teaching the treatment of fractures to undergraduates. Graduate teaching is also being handled by this committee.

The sub-committee is in touch with the several groups interested in medical education in the United States, especially the Council on Medical Education of the American Medical Association, The Association of American Medical Colleges, the Commission on Medical Education, and the Committee on the Teaching of Surgery of the American College of Surgeons. It is hoped that a further consideration of undergraduate instruction in fracture treatment may be secured.

The sub-committee has communicated with those bodies having in charge the examinations of graduates of medical schools for licensure to practice medicine. It has been thought that the Educational Committee might propose to these bodies the National Board of Medical Examiners, and through this group to the various state examining boards the general scope of questions to be asked the recent graduates of medical schools so that pressure may thus be brought to bear in a perfectly legitimate fashion upon the undergraduate school to produce well informed graduates in these fracture matters. These groups are vitally interested in similar problems.

A letter was sent to the National Board of Medical Examiners asking if they would accept suggestions regarding questions on fractures which the National Board would ask. A favorable reply came from the Board desiring to co-operate with this committee. The Federation of State Medical Boards is associated with the National Board of Medical Examiners. A letter from the secretary in Des Moines states that they are in full agreement.

The Sub-Committee on Physical Therapy: Frederic J. Cotton, H. Earle Conwell, Clay Ray Murray. This committee is preparing a carefully edited statement of the status of physical therapy in the care of fractures.

The Sub-Committee on the American Railway Association. The Permanent Committee on Fractures of the Medical and Surgical Section of the American Railway Association made a very constructive report at the May, 1932, meeting in New York. This covered (1) first aid instruction to employees of railway companies; (2) co-operation with the Fracture Committee of the American College of Surgeons in the matter of improving the treatment of fractures—in the adoption of "An Outline of Treatment" when published; (3) X-ray reports as practiced by one of the members, R. C. Webb, chief surgeon of the Great Northern Railway. The X-ray suggestions were the same as those in "An Outline of Treatment" recently published.

Addresses were made by Mr. E. H. Kimball, claims attorney for the Great Northern Railway, editor of the *Bulletin of the Association of Railway Claim Agents;* also Mr. Winter, claim department of the Chicago, Northwestern Railroad. The Association of American Railway Claim Agents will soon co-operate formally by appointing a committee.

The Sub-Committee on Ambulance Equipment and First Aid: Robert H. Kennedy, chairman, Philip H. Kreuscher, W. L. Keller, Hubley Owen. This committee has reported a definite program which is being carried out and it is hoped will extend to every center in the United States. The move has already begun in New York City and has extended to Philadelphia. Throughout the west funeral homes and undertakers provide the ambulance service for doctors. Relations have been established with the National Association of Funeral Directors and it is hoped that they will consider the idea of equipping ambulances and instructing the drivers of ambulances along the lines formulated by the committee.

The Sub-Committee on American Red Cross. The committee has completed its contribution to the first aid work of the *American Red Cross Manual.* This *Manual* is now being printed and a new edition is soon to appear containing these suggestions. The committee is thus in touch with the many first aid classes of the American Red Cross throughout the United States.

The annual Fracture Oration last year was given by Dr. Wm. Darrach, professor of clinical surgery of Columbia University. This year the Oration is to be given by Dr. Philip D. Wilson of Harvard University.

The committee is active in furthering in every way possible a better treatment of fractures.

Standard for Minimum Equipment for Fracture Treatment in Hospitals

1. That all general hospitals be equipped to care for fractures; that the minimum equipment for the transportation and emergency treatment of fractures be the following or its equivalent:

   Thomas upper extremity splints; Thomas lower extremity splints with traction straps, slings and buckle straps; Hodgen splints; coaptation splints, assorted sizes; Cabot wire splints; straight pieces of wood (of assorted length, width and thickness) for splints; plaster-of-Paris bandages; some form of overhead frame for suspension; suitable X-ray apparatus, including a portable machine, if practicable.
2. That it is highly desirable that one individual surgeon be responsible for the supervision of the care of fractures in each hospital service.
3. That special record sheets be used for fracture cases.
4. That a close follow-up be maintained on all fracture cases for such time as necessary to establish an accurate knowledge of end results.

The personnel of the Committee on the Treatment of Fractures is as follows:

Charles L. Scudder, Boston, *Chairman*
Frederic W. Bancroft, New York, *Secretary*

Willis C. Campbell, Memphis
Isidore Cohn, New Orleans
H. Earle Conwell, Birmingham
Salvador Cordoba, Venezuela
Frederic J. Cotton, Boston
William R. Cubbins, Chicago
William Darrach, New York
Frank D. Dickson, Kansas City, Mo.
Eldridge L. Eliason, Philadelphia
William L. Estes, Bethlehem
W. Edward Gallie, Toronto
Fraser B. Gurd, Montreal
Donald Guthrie, Sayre
George W. Hawley, Bridgeport
Melvin Henderson, Rochester, Minn.
William L. Keller, Washington
Robert H. Kennedy, New York
Norman T. Kirk, Washington
Philip H. Kreuscher, Chicago
Walter Estell Lee, Philadelphia
George A. Leland, Jr., Boston
Paul B. Magnuson, Chicago
Clay Ray Murray, New York
Lloyd Noland, Birmingham
Hubley R. Owen, Philadelphia
Dallas B. Phemister, Chicago
Edwin W. Ryerson, Chicago
W. O'Neill Sherman, Pittsburgh
Ernst A. Sommer, Portland
Kellogg Speed, Chicago
Frederick J. Tees, Montreal
Jorge del Toro, Porto Rico
John B. Walker, New York
Roscoe C. Webb, Minneapolis
George E. Wilson, Toronto
John C. Wilson, Los Angeles
Philip D. Wilson, Boston

BOARD ON INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

FREDERIC A. BESLEY, M.D., WAUKEGAN, ILLINOIS, Chairman

THIS year we have to report that through the direction of Dr. Franklin H. Martin, the Director General, the scope of the activities of this Board has been broadened and expanded in the field of medicine and surgery in industry. Dr. Williamson and Dr. Newquist have continued their contacts with large Industrialists in their first-hand fact finding surveys.

The following is a summary of Dr. Williamson's report.

SCOPE OF MEDICAL SERVICE

Only a small percentage of industries included in my survey extend medical treatment beyond the care of injuries and emergent and minor illness arising during working hours. Except for the hospitalization of major accidents and compensable cases requiring operating-room service and institutional care, the treatment of employees is generally restricted to that which can be rendered in the plant dispensary. It was found that 320 plants out of the 375 visited maintained a dispensary with facilities sufficient to supply the above service. The results of our studies show further that 241 (64.2 per cent) of the industries provide pre-employment physical examinations, while 115 (30.6 per cent) have periodic examinations of all or certain groups of workers, 290 companies (77.3 per cent) have some form of benefit plan in operation, such as: (1) mutual aid association maintained by the employees alone or on a contributory basis. The benefits are weekly cash allowances for a stated period payable for loss of time due to illness and non-compensable injuries. Only a small percentage of these associations provide the doctor's services. (2) Relief plan maintained by the company. (3) Group insurance plan which provides benefits for total disability and death, and in a small number of cases an allowance is provided also for illness and non-industrial injuries.

In conclusion, I would recommend that out of the 375 industries surveyed, 172 (45.8 per cent) be placed on the approved list, that 158 (42.1 per cent) be not approved, and that 45 (12 per cent) be conditionally approved pending the receipt of additional information.

Attention is again drawn to the fact that this report is confined to a survey of industries with 500 or more employees and the findings and the figures are not compared with medical conditions that exist in smaller industries.

The following is a summary of Dr. Newquist's report.

Since a Minimum Standard[1] to insure adequate medical care has been adopted by the College it is the yard stick by which we measure such industrial medical service for subsequent rating or approval by the College.

Statistical data—

Number of industries surveyed	246
Number of employees per industry ranged from 250 to 120,000—average	4,317
Total number of employees involved	1,062,000
Total number of employees having payroll deductions for complete medical and hospital service	374,545 or 36 per cent
Total number of employees having payroll deductions to include medical service for families	65,000 or 6 per cent

[1] Surg., Gynec. & Obst., 1932, liv, 441.

Types of compensation insurance—	Industries	Per cent
Self insured	126	51
Indemnity company	70	28
State compensation fund	50	20
Physicians—		
Full time	101	41
Part time	86	34
On call	17	6
None designated	42	19
Dispensary facilities provided by industry	223	90
Pre-employment physical examinations in industry	174	70
Group insurance	170	69
Recommended for full approval by the College	135	55
Recommended for conditional approval by the College	17	6
Recommended for no approval by the College	94	39

We wish to emphasize the fact that the 36 per cent of employees in the industries we have surveyed, who are served medically on a group insurance basis, does not quite represent a true picture of the present situation in industry. We have not visited the smaller industries where such conditions are not so prevalent. Further a complete and comprehensive survey has been made by Dr. Newquist of the Medical and Surgical situation in the state of West Virginia, as it relates to the Workmen's Compensation Law and the State Institutions. This survey was requested and financed by the State Medical Society. His exhaustive report will be published in full.

On Friday afternoon, October 21, 1932, a meeting was held in St. Louis, the program being devoted to scientific discussion on medicine and surgery in industry.

The personnel of the Board on Industrial Medicine and Traumatic Surgery is as follows:

Frederic A. Besley, *Chairman*
Bowman C. Crowell, *Secretary*

John E. Bacon, Miami, Arizona
Samuel R. Cunningham, Oklahoma City
Donald Guthrie, Sayre
Lucian H. Landry, New Orleans
A. D. Lazenby, Baltimore
Charles F. Martin, Montreal
Charles H. Mayo, Rochester, Minn.
Thomas G. Orr, Kansas City
W. O'Neill Sherman, Pittsburgh
Loyal A. Shoudy, Bethlehem
Ernst A. Sommer, Portland
Frederick J. Tees, Montreal
John B. Walker, New York

REGISTRY OF BONE SARCOMA

BOWMAN C. CROWELL, M.D., CHICAGO, Registrar

I HAVE the honor to submit the following report on the Registry of Bone Sarcoma.

During the year records of two hundred two cases of bone sarcoma have been submitted to the Registry and the most of these will be registered. In a few only is the information submitted to the Registry insufficient to justify registration. Five hundred eighty-one of the case records have been circulated and studied by thirty-four different individuals whose names appear on the classification sheets of the individual cases. Selected groups of cases have been issued upon request for educational purposes. The total number of cases in the Registry is now fourteen hundred four and they are classified as shown in accompanying table.

This year there have been eight additional cases of osteogenic sarcoma which have completed their 5-year survival period without recurrence of the tumor. Added to our previous figures this gives 59 in a total of 389 cases of osteogenic sarcoma living 5 years or more following treatment; that is to say, that the Committee unanimously agrees upon these 59 cases as being osteogenic sarcoma. There has been no meeting of the committee as a whole this year. During the absence of the registrar on account of illness the scientific work of the registrar was carried on by Dr. Joseph J. Lebowitz and Dr. R. Bruce Malcolm, to whom much credit is due for the manner in which they conducted the work. Detailed statistics are being prepared.

Osteogenic sarcoma	
Of the femur	289
Other than the femur	366
Ewing's sarcoma	156
Myeloma	53
Lymphosarcoma	6
Inflammation	69
Periosteal fibrosarcoma	24
Metastatic tumor	37
Angioma	9
Hæmangio-endothelioma	10
Benign giant cell tumor	272
Giant cell tumor, malignant	14
Benign osteogenic tumor	37
Unclassified and miscellaneous	46
Not bone tumors	16
	1,404

The personnel of the Committee on Bone Sarcoma is as follows:

Dallas B. Phemister, Chicago, *Chairman*
Bowman C. Crowell, Chicago, *Registrar*

Edwin I. Bartlett, San Francisco
Everett L. Bishop, Atlanta
Joseph C. Bloodgood, Baltimore
Barney Brooks, Nashville
Ernest A. Codman, Boston
Charles L. Connor, San Francisco
James Ewing, New York
W. R. Galbreath, Porto Rico
Frank W. Hartman, Detroit
Henry W. Meyerding, Rochester, Minn.
John J. Morton, Rochester, N. Y.
Channing C. Simmons, Boston

STATE AND PROVINCIAL SECTIONAL MEETINGS

BEGINNING in 1920, the American College of Surgeons has held yearly a number of sectional meetings in an endeavor to bring closer to the surgeon, his hospital, and patients, its extensive program of scientific betterment of surgery, hospitals, and health. The activities of a sectional meeting are patterned on a smaller scale after those of the Clinical Congress, and include surgical clinics arranged by local men, clinical addresses by distinguished visiting surgeons, hospital standardization conferences, scientific meetings, and a community health meeting. The public is invited to the community health meeting which the College arranges with a view to educating the laity in the prevention of disease and the promotion of health and safety measures.

It has been the good fortune of the College to have on its programs outstanding speakers—men who are leaders in their specialties. These men have proved their willingness to co-operate with the College in its work by giving some of their valued time and effort in addresses to the public on health topics, in addition to their part in the scientific sessions of the sectional meeting. Appreciation of the value of these community health meetings has been shown by the large attendance at all such meetings held.

Another feature of the sectional meetings which has stimulated public interest in health and hospital subjects is the giving of radio and school talks by the visiting speakers. The direct contact afforded by talks to high school and college students, whose minds are unprejudiced and open to new truths, is one whose importance can readily be understood, since it is in the prevention of disease that the College is vitally interested. Through radio talks, interest in the community health meetings has been built up to such an extent that, because of the large attendance, overflow meetings in adjacent rooms have had to be provided in many places to take care of those attending.

The following sectional meetings have been held in 1932:

Pennsylvania, Ohio, West Virginia, Pittsburgh, January 25–26; North Carolina, South Carolina, Virginia, Greensboro, January 28–29; Florida, Alabama, Georgia, Louisiana, Mississippi, Jacksonville, February 1–2; and Nebraska, Omaha, February 23–24.

The visiting speakers at these meetings included: Drs. Alfred W. Adson, Rochester; Joseph C. Beck, Chicago; Frederic A. Besley, Waukegan; George W. Crile, Cleveland; William D. Haggard, Nashville; Philip H. Kreuscher, Chicago; Burton J. Lee, New York; Clarence Cook Little, New York; Malcolm T. MacEachern, Chicago; John O. McReynolds, Dallas; and Robert Jolly, Houston.

REPORT ON WORK OF THE CREDENTIALS COMMITTEES AND COMMITTEE ON HISTORY REVIEWS

THE procedure of admitting candidates to Fellowship in the American College of Surgeons requires that each candidate, after filing his application, be recommended by his State or Provincial Credentials Committee before proceeding further with his papers. In each State and Province there is a Credentials Committee composed of from fifteen to thirty-five members who are Fellows of the College, elected to serve on the Committee by the Fellows of the College of their respective State or Province for a term of two years, one-half of the Committee being retired each year.

No candidate is admitted to Fellowship without the recommendation of his State or Provincial Credentials Committee. The members of these committees give generously of their time and meet at a designated city in their State or Province at least once a year and review the credentials of all candidates whose applications are on file from their respective State or Province. Much credit is due these committees for their part in the work of the selection of the men who comprise our Fellowship.

After a candidate for Fellowship has been recommended by the Credentials Committee of his State or Province, he is required to submit one hundred clinical records to the College, fifty in complete detail of major work done by himself and for which he is the responsible surgeon and fifty in abstract of major work at which he has assisted or which he has done himself. These records are carefully examined by the Committee on History Reviews composed of outstanding surgeons in the fields of the surgical specialties from the four leading medical universities in Chicago.

This year 656 sets of histories were received and of that number 631 sets or 63,100 individual histories were examined in detail by the Committee on History Reviews. The remaining 25 sets were not reviewed as the applicants had not yet received the approval of their State or Provincial Credentials Committee. Of those reviewed, 555 sets were accepted and 76 sets were not accepted. Those whose histories were not accepted have the privilege of later submitting additional histories.

Twenty meetings were held by the Committee on History Reviews for the purpose of studying histories and during the four weeks preceding this meeting many additional hours were spent by the members of this committee in order that every candidate's records received this year might be reviewed.

The records, half of which were histories of cases of major operations performed by the candidates and the other half abstracts of cases which they had operated upon themselves or at which they had assisted, were checked with the utmost care, particularly with respect to the pre-operative data indicating the thoroughness with which the case was studied, the technique used, and the end-results.

The histories which were recognized as being of unusual merit were segregated and were the subject of a special review of the committee as a whole for the selection of those which were considered from the standpoint of completeness, accuracy, and form of presentation, to merit special mention.

The members of the Committee on History Reviews who have served this year and to whom the College is greatly indebted for the many hours spent in the laborious work of reviewing the histories submitted are:

James H. Bloomfield
Dwight Freeman Clark
Harry Culver
William C. Danforth
Frank E. David
Joseph S. Eisenstaedt
Harry Jackson
Oscar H. Kraft
Philip H. Kreuscher
Michael L. Mason
Golder L. McWhorter
George J. Musgrave
Oscar E. Nadeau
Rudolph J. E. Oden
Charles H. Parkes
Guy S. Van Alstyne
Charles B. Younger

MEDICAL MOTION PICTURE FILMS

J. BENTLEY SQUIER, M.D., NEW YORK, Chairman

THE importance of motion pictures as a means of disseminating medical knowledge has been generally accepted by the profession, and there is an ever increasing interest in the work being done by the American College of Surgeons in co-operation with the Motion Picture Producers and Distributors of America, Inc. Films being produced are of unusual significance as examples of the possibilities of this method of teaching medicine and surgery.

The Board on Medical Motion Picture Films of the College consists of the following members: Will H. Hays, Esq., New York, honorary president; J. Bentley Squier, M.D., New York, chairman; Philemon E. Truesdale, M.D., Fall River, secretary; W. W. Chipman, M.D., Montreal; Franklin H. Martin, M.D., Chicago; George W. Crile, M.D., Cleveland; Charles H. Mayo, M.D., Rochester; Bowman C. Crowell, M.D., Chicago; and Malcolm T. MacEachern, M.D., Chicago.

The College is very glad to receive for review any medical motion picture film. Many have already been sent in, and a card catalog is being compiled as the films are reviewed, with the idea of securing detailed data concerning all available medical and surgical films. This will enable us to supply information as to what films are available on any special subject, where they can be obtained, and whether or not they are satisfactory for the purpose desired.

During the past 2 years improvements have been made in recording methods and in projection equipment that will be important factors in the application of talking films to the teaching of medicine and surgery. The Board on Medical Motion Picture Films is keenly interested in the development of this type of films and is maintaining close contact with the various organizations which are concerned with this phase of motion picture production and the distribution of the films.

Very large audiences were present at all times at the continuous daily exhibition of medical motion pictures which was one of the features of the Clinical Congress of the College in St. Louis. The 54 films used for these demonstrations included several new talking films with both sound-on-film and disc recording.

Thirty-three reels of medical motion picture films have been approved by the American College of Surgeons and are available for distribution. Many additional films have been reviewed by the College, and though they have not yet been formally approved, our reviewing committees consider them to be an effective presentation of the subject matter, and the procedures shown to be of interest and value.

Information pertaining to medical motion picture films may be obtained by communicating with the College.

THE LIBRARY AND DEPARTMENT OF LITERARY RESEARCH

THE Library of the College is the embodiment of the literary and scientific interests of the Fellows. The collection has grown steadily in the course of the past year through the addition of books and reprints written and presented by Fellows of the College. The reprints are supplied (preferably) in duplicate, making possible the placing of one copy in the Fellow file where it is a record of the work of that Fellow and the second in the classified package library section where it is available for circulation. In addition to the contributions from the Fellows, numerous friends of the College have presented copies of their works and from these sources the collection of current monographs has been augmented. Fellows and friends have likewise generously replied to the request for unbound journals and reprints, and have notified the Library by letter or phone call when such material has been available so that it could be added to the collection already on file in the package library. Several members of the profession regularly keep in touch with the Library by this means.

Two collections are actively growing. The H. Winnett Orr collection of orthopedic works contains valuable historical material as well as later monographs, and the Medical Women's Library, including books and pictures, is made up of interesting material.

The co-operation of the many Fellows who have contributed toward the development of the Library is greatly appreciated. It is hoped, however, that the number of those actively interested in building up this collection may be increased during the coming year. The Library is a phase of the College work in which each individual should have a part. It is his privilege to see that his work is represented in that collection as an inspiration to future generations of surgeons, and it is to his interest to aid in the enlargement of its resources by assisting in the transfer of any available collections (whether they be large or small and whether of current or historical interest). At the present time the oldest volume in the College Library is dated 1555. Any Fellow who has a book of earlier date or any old monograph for which he wishes to find a permanent home, may find a suitable place for it in this collection. College bookplates are available upon request. Those in charge of the Library will be glad to co-operate in making the collection thoroughly representative of the activities and interests of every Fellow of the College.

DEPARTMENT OF LITERARY RESEARCH

In conjunction with the Library, the Department of Literary Research has continued to render to Fellows of the College and members of the medical profession its three-fold service including: (1) package library material, made up of reprints and clippings which are loaned free of charge; (2) bibliographies, compiled upon specific subjects at the request of the doctor; and (3) abstracts and translations, prepared in accordance with the instructions of the one submitting the request. During the past year, the Department has cared for the usual number of requests and the service has been even more prompt than in the past.

Taking into consideration the stringency of the times, every effort has been made to keep the cost of each piece of work as low as is compatible with careful and accurate workmanship. Regardless of the present economic situation, it must be recognized that translations to be of value must be carefully and accurately prepared. However, in many cases the cost of the work can be reduced by the preparation of abstracts or summaries rather than complete translations and by the elimination of case reports and lengthy discussions of non-essential details. The familiarity of the College Research Staff with the medical literature in the various languages (German, French, Italian, Spanish, Swedish, Dutch, and Russian) is an additional factor in the economical preparation of the translations. Thus by wise administration and careful management, those directing the Department have been and are, using every possible means of keeping the cost of research within the reach of every Fellow of the College so that practical considerations will not interrupt the flow of valuable contributions to scientific progress from this great body of men.

ST. LOUIS COMMITTEE ON ARRANGEMENTS

Evarts A. Graham, *Chairman*, F. A. Jostes, *Secretary*, Fred Bailey, Willard Bartlett, M. B. Clopton, William T. Coughlin, Clarence H. Crego, Jr., L. W. Dean, Ellis Fischel, W. C. Gibson, William P. Glennon, Max Goldstein, John Green, H. A. Hanser, Roland Hill, Harvey J. Howard, Charles E. Hyndman, Walter Jones, R. Emmet Kane, W. C. G. Kirchner, W. E. Leighton, Curtis H. Lohr, William H. Luedde, McKim Marriott, Harvey S. McKay, H. G. Mudd, James Mudd, Max Myer, Louis Rassieur, Francis Reder, William E. Sauer, Otto Schwarz, Alphonse M. Schwitalla, Major Seelig, Omar R. Sevin, Carroll Smith, Max Starkloff, Ross Woolsey, O. B. Zeinert.

SUB-COMMITTEES

Ophthalmology and Otolaryngology

L. W. Dean, *Chairman;* Max Goldstein, John Green, Harvey J. Howard, William H. Luedde, William E. Sauer.

Community Health Meeting

Ellis Fischel, *Chairman;* Fred Bailey, Charles E. Hyndman, F. A. Jostes, Francis Reder, John Sutter.

Publicity

Major Seelig, *Chairman*

OFFICERS ELECTED

President: William D. Haggard, Nashville.

Vice-Presidents: Evarts A. Graham, St. Louis; Alexander R. Munroe, Edmonton.

Regents for term expiring in 1935: Irvin Abell, Louisville; John R. Fraser, Montreal; Franklin H. Martin, Chicago; George P. Muller, Philadelphia; Richard R. Smith, Grand Rapids.

Members of the Board of Governors for term expiring in 1935: Fred H. Albee, New York; Edward W. Archibald, Montreal; Samuel C. Baldwin, Salt Lake City; Joseph C. Beck, Chicago; Frederic A. Besley, Waukegan, Illinois; William N. Bispham, Washington; Joseph C. Bloodgood, Baltimore; Frank K. Boland, Atlanta; Frank E. Burch, St. Paul; Henry T. Byford, Chicago; Walter W. Chipman, Montreal; Frederic J. Cotton, Boston; William L. Cousins, Portland, Maine; A. J. Crowell, Charlotte; Thomas S. Cullen, Baltimore; Carl Henry Davis, Milwaukee; Edward P. Davis, Philadelphia; Lee Wallace Dean, St. Louis; Edward C. Ellett, Memphis; George Gellhorn, St. Louis; Oliver D. Hamlin, Oakland; Casper F. Hegner, Denver; George J. Heuer, New York; Gerry R. Holden, Jacksonville; Edward J. Ill, Newark; Jabez N. Jackson, Kansas City, Missouri; John E. Jennings, Brooklyn; Burton J. Lee, New York; Southgate Leigh, Norfolk; Jennings C. Litzenberg, Minneapolis; John Prentiss Lord, Omaha; William H. Luedde, St. Louis; John G. MacDougall, Halifax; William B. Owen, Louisville; Robert Lee Payne, Norfolk; Harold E. Ridewood, Victoria, B. C., Hubert A. Royster, Raleigh; Arthur M. Shipley, Baltimore; Wells Ferrin Smith, Little Rock; George N. J. Sommer, Trenton; Frederic N. G. Starr, Toronto; Julia C. Strawn, Chicago; George W. Swift, Seattle; Howard C. Taylor, New York; Wallace I. Terry, San Francisco; Clarence G. Toland, Los Angeles; Edgar A. Vander Veer, Albany; John B. Walker, New York; George Gray Ward, New York; Horace J. Whitacre, Tacoma.

HOSPITAL STANDARDIZATION

REPORT OF 1932 CONFERENCE IN ST. LOUIS

AN abstract of the papers and discussions presented at the Hospital Standardization Conference held during the Clinical Congress of the American College of Surgeons in St. Louis, October 17-21, 1932, is presented in the following pages. Allen B. Kanavel, M.D., Chicago, past-president of the College, presided.

GREETINGS

Greetings were given by the president-elect, J. BENTLEY SQUIER, M.D., New York, who referred briefly to the Hospital Standardization movement and its accomplishments during the past 15 years.

OPENING ADDRESS

An appropriate address of welcome was made by CURTIS H. LOHR, M.D., St. Louis, in which he referred to the progress made in hospital service generally, mentioning particularly the substantial contribution of the American College of Surgeons through its hospital standardization movement. He announced that five of the city institutions under his jurisdiction were included this year in the list of approved hospitals published by the American College of Surgeons. In making the announcement, he said it would always be his purpose as hospital commissioner to keep all city institutions meeting the high standards. In reference to political, tax-supported institutions, he was of the opinion that such conditions could be avoided if there existed between hospital managements and commissioners the understanding that service to the patient must always be the primary consideration. He appealed to those superintendents of tax-supported hospitals who would stick firmly to their convictions and carry out the best principles of Hospital Standardization regardless of political interference.

PRESENTATION OF THE FIFTEENTH ANNUAL REPORT OF HOSPITAL STANDARDIZATION

FRANKLIN H. MARTIN, M.D., Chicago: Speaking in behalf of the American College of Surgeons, of which this Hospital Conference is the guest, may I, before presenting the annual report of our approved hospitals, say a few words regarding one or more acute problems.

The college has found no more dependable protection against fee-splitting than the influence of the staffs and superintendents of our approved hospitals. We must guard ourselves against the subtle commercialism of some of our own confréres. Every hospital must safeguard its medical staff and the general practitioners by refusing to permit irregulars to practice in the institution. In dealing with a hospital that fails to protect the scientific profession against such invasion, the College has no alternative —it must remove the hospital from the approved list.

Hospitals and the medical profession are being embarrassed by the construction of many institutions by the government to care for disabled veterans of all wars. New hospitals are being built in face of the fact that there are several thousand general and community hospitals with well organized staffs in which these soldier-patients could be properly cared for in their respective communities by their own doctors and at much less expense to the government than by the present program which involves huge expenditures.

Furthermore, it is alleged that from two-thirds to three-fourths of the patients in Veterans' Administration hospitals are comprised of veterans suffering from diseases and disabilities in no way traceable to war service. In order to check this menace, we must act promptly. Letters and telegrams of protest should be sent *at once* to those who are responsible for this government ownership of our activities and to those who are in a position to remedy it.

In order to minimize the cost of hospitalization several points of conduct should be watched: (a) extravagance in building; (b) inefficiency of service; (c) carelessness in segregating patients according to their ability to pay; (d) lack of provision for moderate-priced rooms; (e) disproportionate laboratory, X-ray, and other diagnostic accessories, and possible overcharge; (f) lack of discrimination in applying extras in accordance with individual needs; (g) indiscriminate supplying of food; (h) extravagant assignment of nurses; (i) excessive charges for operating room, anæsthetics, etc.

For 4 years the Hospital Department of the College has urged our approved hospitals to cooperate with the independent practitioners of medicine by offering the services of their institutions for diagnostic purposes through the establishing of health inventoriums. Through furnishing its facilities for the thorough periodic health examinations of individuals by their own physicians, the hospital would become the meeting ground for all regular practitioners, and the haven of the community. It would solve the problems of all physicians and their patients in the conduct of diag-

nostic service, and would insure to the hospital a friendly clientele of transcendent importance. It would aid in the establishment of tumor and cancer clinics, and emphasize also the importance of establishing special services for the early diagnosis of other preventable diseases.

Following is a summary of the results of the 1932 Hospital Standardization survey:

1. Hospitals of 100 beds and over:

Surveyed	1,565
Fully approved	1,418
Percentage fully approved	90.6
Conditionally approved	51
Percentage conditionally approved	3.3
Not approved	96
Percentage not approved	6.1
Total fully and conditionally approved	1,469
Total percentage fully and conditionally approved	93.9

2. Hospitals of 50 to 99 beds:

Surveyed	1,035
Fully approved	549
Percentage fully approved	53
Conditionally approved	99
Percentage conditionally approved	9.6
Not approved	387
Percentage not approved	37.4
Total fully and conditionally approved	648
Total percentage fully and conditionally approved	62.6

3. Hospitals of 25 to 49 beds:

Surveyed	864
Fully approved	127
Percentage fully approved	14.7
Conditionally approved	50
Percentage conditionally approved	5.8
Not approved	687
Percentage not approved	79.5
Total fully and conditionally approved	177
Total percentage fully and conditionally approved	20.5

4. Government hospitals:

(a) Army:

Surveyed	5
Fully approved	5
Percentage fully approved	100.0

(b) Navy:

Surveyed	16
Fully approved	16
Percentage fully approved	100.0

(c) Public Health Service:

Surveyed	25
Fully approved	25
Percentage fully approved	100.0

(d) Veterans Bureau:

Surveyed	70
Fully approved	70
Percentage fully approved	100.0

5. Other Countries:

Twenty-eight hospitals of other countries have been awarded full approval, and are included in the List of Approved Hosiitals for 1932.

SUMMARY

Total surveyed	3,404
Total fully approved	2,004
Total percentage fully approved	60.4
Total conditionally approved	200
Total percentage conditionally approved	5.8
Total not approved	1,170
Total percentage not approved	33.8
Total fully and conditionally approved	2,204
Total percentage fully and conditionally approved:	
Hospitals 100 beds and over	93.9
Hospitals 50 beds and over	81.4
Hospitals 25 beds and over	66.2

THE STANDARDIZED HOSPITAL AS A MEDICAL EDUCATIONAL CENTER

ALLEN B. KANAVEL, M.D., Chicago: The standardized hospital offers the best means of providing a continued education for physicians and is a fertile source of information for the public. So that it may function most efficiently as a teaching center, it is necessary, however, that there be a broader conception of the functions of the standardized hospital. The staffs of these institutions, both physicians and nurses, must divest their minds of the idea that they are founded solely to furnish medical service to the patient coming to their doors. The community hospital as well as the university hospital must become a teaching center.

In their plans for furthering the education of physicians the staffs of the standardized hospital should so organize their activities as to give systematic instruction to their internes, establish residencies for aspiring specialists, and provide adequate opportunities for the education of the general practitioner in the later developments of medicine. Instead of the *laissez faire* attitude toward interne instruction now so common in hospitals, the interne should be encouraged by organized effort to pursue the systematic reading of good medical literature, to carry on the intensive study of group cases, and to make reports of his clinical investigations to the assembled staff, where free discussion by internes, residents, and the staff will clarify his knowledge. Periodic pathological conferences will arouse his interest and be of value to the whole medical group.

Every hospital should aspire to the establishing of residencies of 1, 2, or 3 years according to its size and opportunities. These residents may come from the interne body but it is to be hoped that here the physician who has been out in general practice may find the opportunity for perfecting himself in some special line. These aspiring specialists should be assigned to those particularly qualified to guide them in their reading and practice. They should be encouraged to carry on experimental and clinical studies, a by-product of which would be medical articles for publication; but the greatest value would come to the resident through the development of his habits of observation, perfection of his critical analysis of disease, and particularly of his imagination.

The standardized hospital should be the center for the dissemination of new procedures and new knowledge to the practicing physician. We have all recognized our need of continued instruction and attempted to meet it by attending medical meetings and post-graduate clinical weeks. The inadequacy of didactic teaching of this type is too well known to deserve comment. Of much more value would be instructional courses given in the standardized hospitals by qualified members of the profession, not lectures but systematic laboratory courses and actual demonstrations of pathological material, chemical procedures, the treatment of emergencies, the recognition of uncommon conditions, and the treatment of the simpler diseased conditions coming within the realm of the specialist. So far as possible such courses should consist of actual work by the practitioner and be limited to a few participants.

Of equal importance is the systematic instruction of the community in the knowledge of the principles of scientific medicine. Addresses to the community upon practical subjects by the local profession under the auspices of the hospitals and sponsored by civic organizations such as churches, lodges, business men's organizations, women's clubs, etc. will arouse general interest. Such instruction might well include special group classes in domestic science, the preparation of diet in health and disease, simple nursing aids, care of expectant mothers, care of babies and the preparation of their foods, lectures upon contagious diseases, the recognition of emergencies, sexual hygiene, and marital relationships.

The hospital should foster the health inventorium by providing facilities for the profession to carry on this work in a systematic manner at a nominal expense. Such public instruction will not only be of value to our people but will also attach to the hospitals the loyal support of our citizens and diminish the menace of quackery.

Discussion

HORACE J. WHITACRE, M.D., Tacoma, Washington: Undoubtedly, adult education, or a continuation of education after the intensive study of college days, is one of the real problems of society, whether this education concerns general problems or specialized fields. There is perhaps no social group that has done a better job of continuation study than the medical profession, as it is carried on through county, state, national, and specialized society meetings, where advances in scientific medicine are discussed and general information advanced. The hospital of each community provides a very practical agency, however, which is not covered by any of the activities mentioned, and has great potentialities for the increase of practical, directly usable knowledge among physicians.

There need not be any conflict between the educational program of the hospital staff and that of the county medical society. The county medical society is the legitimate place for formal papers and organization work, while the program of the hospital staff meeting is confined strictly to the presentation of specific cases in the hospital, demonstration of diagnostic methods, laboratory technique, and autopsy findings.

The most important place for the development of a well organized educational program within a hospital is the community where there is no teaching institution. I represent such a community. We feel that the most important element in our hospital educational organization is a full time pathologist who has definite teaching ability. We hold regular monthly staff meetings, a weekly medical clinic, a weekly tumor clinic, regular meetings of an interne and an ex-interne group, and a continuously operating anatomical dissection department. In all of these our full time pathologist is in a large measure the leader, and to a considerable extent the hub of the wheel.

This arrangement prevents us from degenerating to the unprofitable routine of reporting successful cases, and maintains a status of scientific alertness.

THE CHANGING RELATIONSHIP OF THE DOCTOR TO HIS WORKSHOP

G. HARVEY AGNEW, M.D., Toronto: The influence of the hospital on the practice of medicine while evolutionary has been actually revolutionary. A few decades ago the average doctor was very little interested in the hospital. The majority of patients were treated at home. Only as a last resort would a patient consent to go to a hospital of which there were very few outside of large cities, and those were comparatively "closed" to a small staff.

Now the picture is changed. There is a vast chain of hospitals everywhere. More and more medical work is being transferred to the hospital so that the doctor must ally himself more closely with his workshop today than he did in the past. The medical profession is realizing its responsibility and obligations to the hospital, and staff appointments are now properly appreciated. An increased interest is being manifested in staff meetings with more co-operation and *esprit de corps*. Particularly gratifying is the greater co-operation between medical staff and the administration groups in hospital work.

What of the future? Hospitalization cannot but increase thereby making it more essential than ever before that every doctor have access to some hospital. The effort to lessen the cost of diagnosis will probably result in greater utilization of hospital facilities by doctors whose co-operative practices may be grouped about the hospital itself. Should health insurance ever come, the experience of other countries would indicate that the relationship of a large portion of the profession may undergo considerable change.

The increasing utilization of public ward services by industrial and social organizations for the hospitalization of patients on a benefit or co-operative scheme, many of whom could afford to pay for a physician, is victimizing the profession to an intolerable degree. In a Report of the joint committee

of the British Medical Association and the British Hospitals Association in Great Britain there is shown a definite preference for the payment of the visiting staffs.

It is becoming increasingly apparent that the physician's activities and interests, his future, his very life are indissolubly bound up with the hospital. No more can he hold aloof from the hospital, scorn the multitudinous staff responsibilities, or maintain his professional prestige without that very stimulating and chastening contact with his colleagues in ward and theater.

And with the realization of this partnership has arisen a new sense of responsibility, of obligation toward the hospital. The more this duty is realized, the more is a staff appointment appreciated—not as a divine right, but as a privilege, as an opportunity for professional improvement, for scientific stimulation, and for greater service to the sick poor.

Discussion

WILLIAM D. CUTTER, M.D., Chicago: A recent analysis shows that in the United States more than 90 per cent of the practicing physicians have hospital connections. The doctors themselves have been most active in increasing the number of institutions and in devoting a larger proportion of their own time to practice within hospitals. Obviously, by so doing the physician saves a great deal of time and energy otherwise consumed in visiting his patients in their homes. In hospital practice the doctor saves money for it relieves him of the necessity of providing in his office such expensive equipment as operating rooms, laboratories, and X-ray machines for diagnosis and treatment.

In the hospital the physician has at his command trained assistants, internes, nurses, and technicians who will carry out his orders, supervise treatment, aid in diagnoses, and, in general, greatly increase his effectiveness in caring for the patient.

Another substantial advantage which comes to the physician practicing in the hospital is derived from the opportunities for contact with his professional colleagues. Casual meetings and formal consultations enable him to keep better informed as to what others are doing in his own and related fields.

The present regimen has proved itself of greatest advantage to the patients who save time otherwise consumed in going back and forth to the doctors' offices. Moreover, it is an indisputable fact that better care can be obtained in the hospital than in the home.

Slowly but surely the doctors are transferring their care of ambulatory patients to offices which now are provided in many institutions, resulting in the numerous advantages already cited. Even the hospital finds it advantageous for the physician to carry on his private practice within its walls for it makes him more readily available at all hours of the day.

In connection with problems of health insurance, some hospitals have already undertaken to supply their communities with medical service at a fixed rate. Inasmuch as these arrangements sometimes include medical as well as hospital care, it is clear that our profession is vitally concerned to see that such arrangements are based upon due regard for the physicians' rights—otherwise, the hospital, or insurance company, may assume the right to sell the doctor's services without giving him a voice in determining the conditions under which he will render those services.

Surgeons, more than any other group of physicians, are dependent upon hospital facilities and, at the same time, they furnish a larger quota of patients. Therefore, it is to them that we may justly look for leadership in adjusting the relationship of our profession to the community through the hospital, in such manner as to safeguard the vital interests which we have at stake.

MEDICAL AND HOSPITAL ECONOMICS

FREDERIC A. BESLEY, M.D., Waukegan, Illinois: The Hon. Newton D. Baker has said recently that "America will be on trial this winter," and we might paraphrase this to state that the American hospital system will be on trial this winter. The solution and the answer to all the problems involved in the situation cannot be prophesied accurately.

The mounting and ever increasing cost of the maintenance of hospitals has been a problem that has confronted all hospital managements during the past decade and has required the continued and correlated efforts of the best financial minds to cope with these changing conditions which are rapidly becoming more acute. Hospitals have been compelled to increase their budgets because of the cost of elaborately equipped X-ray departments and complete scientific laboratories, with their accompanying staffs of high salaried technicians. The supplanting of the 3 year course for nurses instead of 2 years of training, and the demands of physicians and surgeons for more scientific care for their patients in hospitals have meant an increasing financial budget.

It is an evident fact that the average patient cannot afford to pay for the high quality of service which he needs and to which he is rightfully entitled. Some arrangement must be evolved whereby this enormous financial burden can be distributed and paid collectively. Perhaps the costs of hospitalization of many patients could be assumed by some collective agency such as insurance.

It is not exactly accurate to say that communities are overhospitalized. True, there are many unoccupied beds throughout the country. But it is just as true that there are as many and more patients requiring hospitalization who have not the financial resources to avail themselves of these unoccupied beds.

If the Veterans Administration hospitals would restrict their services to diseases and injuries contracted in the line of duty and to dependents of those who made the supreme sacrifice, then many of the

now unoccupied beds in other hospitals would become occupied.

HOW THE HOSPITAL MANAGEMENT AND MEDICAL STAFF CAN CO-OPERATE IN REDUCING THE MORTALITY OF APPENDICITIS

JOHN O. BOWER, M.D., Philadelphia: Approximately 20,000 die annually in the United States from appendicitis and the complications associated with it. The death rate of 183 American cities with an aggregate population of 43,000,000 in 1931 was 17.9 per 100,000. The increase in mortality from 1910 to 1931 in 60 cities in the United States with an aggregate population of more than 28,000,000 was 31.5 per cent. The death rate per 100,000 in these was 17.4. In 64 foreign cities of corresponding importance with an aggregate population of more than 56,000,000 in 1931 the death rate was 8.0 per 100,000. Why is the death rate in the United States 124 per cent greater than in Europe? Our medical and surgical abilities are certainly equal and our hospital facilities just as good.

Pre-hospital factors are responsible. This accounts for the futility of the efforts of physicians and surgeons to reduce the mortality. The responsibility for the outcome of the patient who enters the hospital with acute appendicitis is the surgeon's. Yet in 90 per cent of the deaths the advice of family, friends, druggist, and family physician has contributed more to the fatal outcome than the surgeon's management.

Any plan to combat the increasing mortality of acute appendicitis must include a program of publicity. The problem of the increase is not the surgeon's primarily; it must be met by the co-ordinated efforts of a national organization such as the American College of Surgeons, the departments of health of every city, and by the medical staff and management of all hospitals. The success of the plan for the reduction of mortality of acute appendicitis as it pertains to the individual hospital depends upon co-operation between staff and management.

The member of the staff chosen by the chief of staff and the medical director or superintendent should preferably be a surgeon, but if he is vitally interested in the campaign, experienced in clinical research, and willing to supervise the details incident to statistical studies, he should be chosen without regard to rank or preference.

For a successful plan of publicity there must be: (1) an analysis of all clinical records of acute appendicitis both private and ward of the previous 2 years; (2) presentation of results of analysis to the medical staff and those physicians sending patients to the hospital; (3) a letter with explanatory detail enclosed (in the form of a sticker warning) mailed to above mentioned physicians; (4) surveys made and letters noting any progress together with stickers sent out at varying intervals of from 3 to 6 months; (5) a complete survey made at end of current year with results.

As soon as the survey is completed, the results must be presented to the staff, outside physicians, and the public. Sticker warnings sent to the family physician, who in turn sends them to his clientele, will be particularly effective. However, one of the greatest aids is the frank discussion of the hospital mortality; it must be talked about; it must be visualized, it must be brought into the open.

OXYGEN THERAPY IN HOSPITALS, EQUIPMENT, AND MANAGEMENT OF SERVICE

WILLIAM THALHIMER, M.D., Chicago: Anoxæmia is the one fundamental indication for treatment with oxygen. The only accurate method for determining the degree of anoxæmia is actually to determine the amount of oxygen present in the arterial blood. The use of oxygen therapy in our hospital has increased until now we are trying to anticipate the development of anoxæmia and prevent it; or if we cannot do this; at least to use oxygen at the earliest indication of anoxæmia.

The advantages of the oxygen room are accurate and constant control of percentage of oxygen, conditioning of the temperature, and humidity of the atmosphere; ability to give the patient complete nursing and medical care as in any other room, relieving the patient of the sense of confinement, as in an oxygen tent. The disadvantages of the oxygen room are mainly that it is more expensive to erect, uses more oxygen, and requires a special nursing force.

The advantages of oxygen tents are mobility; that is, one can bring the tent to the patient's bed; they are less expensive than oxygen rooms, and require less oxygen. The disadvantages are that some patients are badly affected by the feeling of confinement in the tent; very restless patients are difficult to control, and delirious patients impossible to control. It is difficult to maintain a 50 per cent oxygen content because of having to open the tent to feed and care for the patient; it is more difficult to give nursing care; more difficult to control the temperature; oxygen tents require constant supervision by someone with the proper technical training.

The nasal catheter method has the advantages of simplicity and economy. The main disadvantages might arise from discomfort caused to the patient, limitations when the patient is restless or delirious, and the necessity of care on insertion of the catheter by a physician and constant supervision by him. There is the danger that if the catheter is inserted too far into the pharynx, that the patient may be forced to swallow the oxygen mixed with air, or the stomach may even become distended with this atmosphere.

It is imperative that one member of the clinical staff be interested in oxygen therapy from both the therapeutic and research points of view. He can train a technician, nurse, or interne in all of the essentials; he can stimulate the rest of the staff to maintain an open mind as to the value and usefulness

of oxygen therapy. He will find many fields still open for research and many opportunities for careful scientific observations.

For the proper care and installation of oxygen tents, for the use of an oxygen room, to be certain that 50 per cent oxygen is being maintained, and that equipment is not being neglected or damaged, it is absolutely necessary to have the services of an able technician.

It is my hope that it will be possible to reduce the cost of oxygen therapy service in hospitals and in homes so that oxygen treatment can be given a larger trial, earlier in the course of various diseases, and so that many more observations can be made to determine the extent of usefulness in what I consider a very valuable therapeutic aid.

Discussion

GEORGE W. CRILE, M.D., Cleveland, Ohio: It is the custom at the Cleveland Clinic to deal with depression and shock prophylactically. Since the basis of energy is oxidation, it is through oxidation that the electrical potential of the cells is built up and maintained, and therefore it is through oxidation that the normal activity of all the organs and tissues of the body is maintained. In depression and shock there is a failure of the actual oxidation in the body, that is to say, a failure of the internal respiration of the body, corresponding to the degree of the depression and shock. If in the course of a surgical operation the patient is depressed by surgical shock, or by hæmorrhage, or by infection, or by crises of hyperthyroidism, it means that countless millions of organic molecules have broken down and these can be restored and repaired only by rest, sleep, and normal oxidation.

We treat our patients on a statistical basis; that is, our indications for preventive treatment are based upon the statistical evidence, not the clinical evidence in each group of patients. If we are proposing to perform an operation upon the common duct in a jaundiced and sick patient, if we are resecting the large intestine for carcinoma, if there is an emaciated patient with hyperthyroidism or a case of hyperthyroidism in which emaciation, myocardial decompensation, nephritis, etc. are present, if a resection of the stomach is to be done, if for any reason the risk is poor, then regardless of the cause, in all these cases we give a blood transfusion in advance of operation, intravenous injections of glucose, injections of normal saline and urge water by mouth or give it by hypodermoclysis—thus the electrolytic balance is built up before the operation, and then during the operation we maintain the body temperature in certain of these cases by diathermy.

We use local, regional, or spinal anæsthesia together with a small amount of nitrous oxide oxygen; we avoid deep, general anæsthesia which interferes with the internal respiration, that is, the oxidation, which means that the anæsthesia itself is doing the same thing to the patient as the surgical operation. When we have finished an operation performed under the above listed conditions, the patient's condition may seem to have been very little disturbed by the operation, but we know from statistical experience that that patient is still in the bad risk class. We, therefore, put the patient immediately into an oxygen tent and give him infusions of saline solution and we protect him against pain. We continue the protection of his body temperature by applying diathermy if there is any fall below the normal.

One of the most important measures of all is the immediate use of oxygen; that is, putting the patient into an oxygen tent. By doing this we have to an extraordinary degree cut down the mortality rates in these various bad risk patients. For instance, we now have a series of 1,473 operations for hyperthyroidism in patients under 45 years of age without a death. We have seen the mortality rate fall in the whole group of bad risk operations.

Not only does this general plan of maintaining a high level of resistance in the patient prevent the breakdown of the myocardium, of the kidney, the liver, the pancreas, and the brain, but it sets up the best type of defense against infection, pneumonia, and wound infection. In other words, we have set up a formula for raising and maintaining the vitality of the patient before, during, and after the operation; and one of the essential factors in this formula is the oxygen tent.

PERTINENT PROBLEMS AFFECTING HOSPITALS AND THEIR SOLUTION—FROM A NATION-WIDE SURVEY

E. MURIEL ANSCOMBE, R.N., St. Louis: Several factors are contributing to the lowered occupancy of our hospitals. Non-tax-supported hospitals are doing more than their share of free work, but are being deprived of the patronage of patients who can afford to pay, by the admittance of private patients to city hospitals. Some plan should be evolved whereby private patients are entirely excluded from public institutions, and non-tax-supported hospitals given financial aid for each charity patient treated.

Group insurance may be a partial solution of the hospital's financial problem. It should, however, provide protection for the individual and prove satisfactory to the physicians.

Articles and editorials which have appeared recently in different professional magazines indicate the need of a specific preparation for the hospital administrative field. Should not some provision be made for an educational program and *registration* of hospital superintendents that will make it incumbent upon hospitals to employ a properly prepared superintendent if they wish to obtain institutional membership in the American Hospital Association and become approved by the American College of Surgeons?

Boards of Trustees would be taking a step in the right direction by appointing to their staffs only those physicians who have no other hospital

affiliations. This would stimulate a sense of ownership and personal responsibility in institutions. With their patients concentrated in one hospital physicians could devote more time to planning and carrying out an intensive teaching program. They could give closer supervision to the patient's history and have more time for research work.

Without careful supervision and follow-up work internes will not get the best which the hospital has to offer. Hospital administrators should feel their responsibility in the development of the interne. The largest hospital does not always furnish the best training; it depends largely upon the organization, the research spirit which prevails, and the interest of the staff members in the interne group.

Hospitals are being criticized today for turning out too many nurses. The adoption of uniform standards by a national board or commission, working in conjunction with the National League of Nursing Education, would automatically eliminate many schools and just as definitely result in a marked decrease in the number of students who are admitted to our schools.

Discussion

W. HAMILTON CRAWFORD, Hattiesburg, Mississippi: For several years it has been my conviction that field secretaries should be established at geographical points by the American Hospital Association so that a more intimate relationship might be developed between the members and the association.

The pivot man in any hospital is, of course, the superintendent. How may we be expected to convince a public that certain recognition should be extended hospitals when staring so many communities in the face is an exhibit of incompetency bearing the title of superintendent?

Several superintendents today are uncertain of the permanence of their positions because of competition of members of their boards seeking to supersede them. We may expect this situation to continue until an intelligent standard is set up for extending recognition to those qualified.

Why not create the American College of Hospital Superintendents to stand out as a separate and distinct, ethical and influential college, presenting fellowships only where requirements have been fully met?

A plan of public relations as outlined by the Committee of the American Hospital Association would undoubtedly create the proper perspective between hospitals and society.

A three-fold program to solve pertinent problems affecting hospitals should include, it seems to me, the following:

1. Program of *public relations*.
2. American Hospital Association program as advocated by *Plan and Scope Committee*.
3. Establishment of the *American College of Hospital Superintendents*.

ECONOMIC CONDITIONS AS THEY AFFECT CANADIAN HOSPITALS AND HOW THEY ARE BEING MET

ARTHUR J. SWANSON, Toronto: The hospitals of both Canada and the United States are having a difficult time and are frantically searching for new means of increasing revenue. We in Canada have endeavored to gain some measure of relief through five major means.

1. *By reducing expenditures.* In addition to the reduced prices of commodities, many savings can be made through using more up-to-date equipment, through rearranging the duties of the staff so as to allow more evenly distributed employment, and through the rearrangement of hospital clinics so that space is kept busier.

2. *By selling hospital service to the community.* By setting out deliberately to give the utmost in service to the public and your staff doctors, a considerable amount of business can be salvaged at this time. To my mind, it is good service that is going to be the deciding factor as to whether the hospitals will be kept busy.

3. *By making the state assume its responsibility to indigent and part pay patients.* In Ontario the Government sets the rate which may be charged public ward patients at $1.75 per day, and 90 cents for infants born in the hospital, this amount to be paid by the patient; or, if that is impossible, by the municipality sending in the patient. In addition to this $1.75 per day, the Government of the Province pays 60 cents per day for every patient in the public wards and 30 cents per day for every infant born in the institution. It is admitted that this rate does not by any means cover the cost of maintaining the patients even in the lowest priced accommodations but the hospital receives a definite amount for patients who otherwise would be treated free. In other provinces the rate varies. When it became evident in Ontario that the government intended to reduce the grant a large deputation of the provincial hospital association met the Prime Minister and some of the Cabinet members and succeeded in maintaining the grant rate. This indicates what a well organized hospital association can do to keep the needs of the hospitals before the Government and the public at all times.

4. *By relief from taxation and other duties.* Thousands of dollars are saved annually for Canadian hospitals because most articles of hospital equipment are exempt from duty. Moreover, the hospitals are exempt from the payment of sales tax on everything purchased for hospital use, even including material used for additions to existing buildings. The exemptions were made through the efforts of our various hospital associations and our very energetic director of Hospital Service for the Canadian Medical Association.

5. *By a contributory system.* This system may be called "hospital insurance," or "advanced payment system." Call it what you will, this is something which must be seriously considered by all hospital

administrators before long. Some of our hospitals have found this system a very satisfactory way of insuring revenue. Prepayment certificates are being issued whereby potential patients buy in advance certificates entitling them to a definite value in hospital service. By means of these certificates, payment for hospitalization is spread over a considerable period before, during, and after the actual period of hospitalization.

OBLIGATIONS OF GENERAL HOSPITALS IN PROVIDING BETTER SERVICE FOR THE CANCER PATIENT

BURTON J. LEE, M.D., New York: The American College of Surgeons in co-operation with the American Society for the Control of Cancer has been engaged for some years in the organization of cancer clinics in this country and in Canada. Although splendid cancer institutes exist in some of the larger centers, the bulk of the vast numbers of patients suffering with cancer inevitably find their way to large general hospitals where adequate service should be provided. These institutions must realize the obligation which rests upon them in connection with this major health problem.

To meet this need cancer clinics with satisfactory surgical and radiological equipment and well trained staffs are being organized all over America. Indeed, no large general hospital can be considered a complete institution today unless a well organized cancer service exists within its doors. It must be borne in mind, furthermore, that cancer itself is a distinct field apart from general medicine and surgery.

A cancer clinic to be complete must incorporate the new science of radiology with the co-operation of an intelligent and interested radiologist who has at his hand modern radiological equipment for diagnosis and treatment. An adequate supply of radium is necessary, but more important is a group of men trained to use this agent intelligently. The technique of radium therapy is a science and an art in itself, but it cannot be separated from proper surgical technique inasmuch as many special surgical procedures must be carried out in connection with radium therapy. A pathologist interested in neoplastic diseases is one of the key men in the personnel of a cancer clinic. But the care of a cancer patient can never be assigned to a single individual. Group judgment is necessary if the patient is to receive the best in diagnosis and treatment.

Discussion

BOWMAN C. CROWELL, M.D., Chicago: The success of the hospital today can be measured only by the condition of its patients after they have left its doors. Yet the future of the discharged patient is in most instances entirely unknown to hospitals. He might well be called the "forgotten patient."

Follow-ups are important not only to gage the efficiency of the hospital's staff, but to make sure that the treatment given the patient will be of more than temporary duration.

Hospitals must induce their patients to return for re-examinations. If they desire to make their services of real and lasting benefit, they must install new record systems with a workable plan for definite follow-ups.

FOLLOW-UP AND STUDY OF END-RESULTS AS CARRIED ON BY THE MAYO CLINIC

ALFRED W. ADSON, M.D., Rochester: The taking of careful histories and the recording of physical and laboratory reports are essential to the diagnosis of a patient. But the treatment of future patients with similar ailments depends upon the results accomplished by the medical or surgical treatment instituted. It is true that one may be capable of remembering the results obtained in some particular case or in a small group of cases, but in order to make a thorough analysis of a large series of cases, much depends upon the follow-up study.

In some departments of the Clinic, follow-up data are obtained by personal letters to family physicians or to the patients themselves. In other departments circular letters pertaining to the specific disease are mailed at regular intervals or at times when special investigation is being made. These data are often supplemented by photographs, roentgenograms, laboratory, ophthalmological, neurological, and physical examinations while others who have failed to get the desired results are encouraged to return for re-examination, which affords evidence for the more accurate follow-up study. Letters from patients are not always reliable, as the results may be colored by the amount of the outstanding account or the disability insurance they are receiving. The report of the family physician is the most valuable follow-up system.

Once all these data are acquired, it is essential to record them either on the history, on charts, or on cards for mechanical tabulation which permits comparison of pretherapeutic findings in order to evaluate results accomplished. Therefore, it is obvious in comparing the results obtained by the various therapeutic measures that one readily learns which treatment is valuable, and by exposing our faults further thought is stimulated to arrive at the correct diagnosis and the best treatment to employ.

FUSING THE TRIPLE VIEWPOINTS ON NURSING—DOCTORS', NURSES', AND HOSPITAL EXECUTIVES'

MARY M. ROBERTS, R.N., New York: Our system of nursing education has been surprisingly good, but it is now outworn. We need a new system to free the hospitals, which are service organizations, of the economic responsibility for educational institutions. The most vital part of a nurse's training must always be secured where the patients are—in the hospital—but by wiser use of existing educational institutions for science courses and other academic work, the change can be brought about. A good deal depends upon the hospitals' willingness to so organize their nursing services that there shall be

at least a skeleton organization of graduate service, a service apart from the numbers of graduates needed for supervision. Into well organized services we shall be able to project students for training in the expectation that they will constantly see, and therefore, practice good nursing—an outcome deeply desired for patients by doctors and nurses alike.

Today we have many more nurses than we need to meet effective demands, and much of the overproduction is of poorly prepared nurses. In a study of the nursing services of sixteen middle western hospitals, the American Nurses' Association recently discovered that only 33 per cent of the applicants were eligible for staff nursing.

Doctors know extraordinarily little about nursing. With their willingness to help, and with the cooperation of nurses and hospital executives, together with the aid of the public, nurses can be better prepared. It is upon the public that the responsibility for the education of public servants should rest.

Hospital nursing service and *school of nursing* should never be thought of as synonymous terms even when the school contributes richly to the service and the service to the school. The hospital is responsible for its own nursing service. It should be freed from the economic and educational burden of a school.

School of nursing must be made to mean a place in which young women are prepared for service as *graduate nurses* in what may be called first level positions. This implies a sufficient body of basic sciences to provide a background for a rounded clinical preparation, including mental and communicable disease nursing, and the principles of public health. Further preparation than that should be secured through postgraduate courses.

Discussion

DONALD GUTHRIE, M.D., Sayre, Pennsylvania: I do not believe that the medical profession criticizes nursing for a lack of training or practice. Most of the criticism is brought forth because of the nurse's inability to adapt herself to her patient and to her own surroundings.

Psychology has been wisely added to the curriculum, but as a science it is difficult for the average pupil to understand. Would it not be better to teach psychology in a more practical way and to bend our efforts toward developing the personalities of our students? I am satisfied that if our nurses could be skillfully trained in practical psychology there would be much less criticism of their work by the public and by the medical profession. The art in nursing and in medicine must never be replaced by pure science, for if it is, it will be unfortunate for both professions.

BASIC STANDARDS FOR SCHOOLS OF NURSING

REV. ALPHONSE M. SCHWITALLA, S.J., Ph.D., St. Louis: In advocating any set of basic standards for schools of nursing, the first principle to be recognized by the school is the *educational level from which its students are derived*. Essentially, the school of nursing is a professional college. That does not mean that schools of nursing should blindly and uncritically take over the whole sum and substance of college administration, but the school's attitude toward a student should be that of the solid college of arts and sciences.

The school of nursing must understand *the life for which it is preparing the student nurse*. Because of the constantly increasing stress and complexity of our world, the school must differentiate between cultural courses, basic sciences, medical courses, and nursing courses in the curriculum. If the school of nursing is of collegiate rank, then surely it must impart fundamental collegiate instruction in the principles of the use of English, in public speaking, in the fundamental viewpoints of economics—in addition to theoretical preparation in medical and nursing courses.

It is incumbent upon the school of nursing *to develop, to instill into its students, and to foster in them the ideals of the nursing profession*. From her studies there should develop in the mind of the thoughtful student at least the beginnings of a formulation of the nurses' place in the nation's life. And from that understanding there will be derived a broader outlook on life, a deeper insight into the problems of mankind, a firmer grasp upon the fundamentals of living which enable the individual nurse to rise above those smaller annoyances concerning her employment, her hours of work, and the nature of her work, which have in the past stood in the way of success of many creative endeavors in the field of nursing education.

Discussion

J. DEWEY LUTES, Chicago: One requirement for entrance into a school of nursing that seems to be generally accepted is that of a high school diploma —and rightly so. However, this must not be considered proof of a girl's ability to become a nurse. It is merely proof of her intellectual capacity to reach a certain level by way of a prescribed route.

We must make provision in our schools of nursing against the graduating of those who fail to acquire the proper attitude of mind. It is not enough to pour out instruction of which a sufficient amount can be retained in the memory to pass a written examination. We who administer in the schools of nursing must analyze students in such a manner that the failures are eliminated.

We must not permit education to stop at the end of the school career; we must encourage and put into operation some plan whereby the individual will continue to learn and improve herself and her profession as the years pass.

The members of the faculty must be selected on the basis of their ability and fitness in this special field. And graduate nurses must be selected for departmental positions in the same careful manner in which a student is admitted to the school.

DEPRESSION DEVELOPMENTS IN RELATION TO HOSPITAL ECONOMICS

B. C. MacLean, M.D., New Orleans: More attention has had to be given during the depression period to the economies of hospital operation; as a result, many new experiments have been tried. It was inevitable that some startling schemes would be advanced in a frantic attempt to bolster revenue. Hospitals have been advised to open beauty parlors, barber shops, and soda fountains. It is wise to remember that a hospital should not stray too far from its functional field even in times of depression. On the other hand, there are some profitable activities such as the operation of a doctors' exchange or a nurses' registry and the provision of office space for doctors which can reasonably be considered within the province of a hospital and which can be successfully instituted if local conditions permit.

Interesting to all hospitals is the success which has attended the inauguration of cafeteria systems for the feeding of employees, nurses, and internes. Another development has been the establishing of central supply rooms for surgical supplies and also central nourishment kitchens for the preparation and dispensing of the between meal extras.

Nursing education is more theoretical today than it was in the past. But the main purpose in any system of nursing education is always the same and cannot be too greatly emphasized—*the comfort and care of the patient.* It might help if our nursing faculties contained more bedside preceptors and less classroom Ph.D's.

Hospital insurance, although not a panacea for all our ills, seems to offer at this time the greatest promise of deliverance from economic pain. The medical profession should realize that hospital insurance plans, as at present conceived, offer a bulwark of defense against other radical trends which might revolutionize the practice of medicine.

The Federal Government itself has entered into direct competition with private hospitals in the care of veterans whose disabilities have been incurred outside any line of public duty either civil or military. It is to be hoped that the splendid efforts of the medical and hospital associations to stem this tide may be successful.

EFFICIENCY AND ECONOMICS AS APPLIED TO THE X-RAY DEPARTMENT

Edward H. Skinner, M.D., Kansas City: In many localities there are several hospitals, none of which offers sufficient within its own walls to attract or pay for the full-time consultative service of a radiologist. With technical demands satisfied by a full time technician, one radiologist can easily serve at least four hospitals each day. Modern roads and rapid transportation make 50 mile trips as easy as any twenty-five blocks in street car days.

There is no reason why the technicians in small hospitals should not serve both the radiological and pathological laboratories. Bookkeepers, record clerks, and operating room nurses may easily become radiological technicians without sacrifice to either service.

The compact arrangement of all laboratories and operating rooms would aid in the co-operation of technical assistants; avoid many steps by many people; concentrate and increase the demands for laboratory examinations; promote more consultations between attending physicians and laboratory consultants; eliminate the gossip infested doctors' lounge rooms.

The sterile cystoscopic room can be adjacent to the X-ray department and be served by the single X-ray transformer for pyelograms. The plaster room can be next door and be served with fluoroscopic fracture service. The combined plate viewing and radiologist's office should contact the pathologist's sanctum to afford that co-operative consultative service so beneficial to attending surgeon, physician, and patient.

Economies in radiological fees can be effected by securing the co-operation of the staff in asking for radiological consultation for the particular diagnostic problem rather than making a blanket demand for extensive and costly technical procedures.

The co-operative fluoroscopic consultation of clinician and radiologist can be a great saving and afford increased values to the patient and greater glory to the hospital's reputation. Stereoscopy is beautiful but rarely necessary.

EFFICIENCY AND ECONOMICS AS APPLIED TO THE PHYSICAL THERAPY DEPARTMENT

John S. Coulter, M.D., Chicago: It is possible for every hospital whether large or small to have a physical therapy department without the expenditure of a great sum of money if certain principles are observed. First of all, to be efficient a hospital physical therapy department must be under the control of a physician. In a large city this can be accomplished without any difficulty. In the smaller town where there is no physician devoting his time to physical therapy, this department should be under the direction of the X-ray department.

The second requirement is well trained personnel. At the present time there is no course which definitely provides X-ray technicians practical training in physical therapy. It is hoped that the societies of X-ray technicians and physical therapy technicians can work out a satisfactory course of not more than 12 months to fulfill this need, inasmuch as many calls for technicians request an individual capable of taking charge of the technical work in both the X-ray and physical therapy departments.

A hospital physical therapy department can be started without any apparatus except that made by the hospital carpenter, mechanic, and electrician. Proper equipment is essential for much of the needed treatment but no hospital should hesitate to start a department without equipment so long as available space is provided, and a physician is placed in charge, assisted by well trained personnel.

In order to put before the hospital staff information relative to physical therapy, one staff meeting a year should be devoted to the demonstration of the work of this department. Demonstrations should be scheduled for clinics; lectures given to internes and nurses.

Records are the most important aids in the scientific success of a hospital physical therapy department. To be of value they must conform to the general record system of the hospital and form part of it.

EFFICIENCY AND ECONOMICS AS APPLIED TO THE ADMINISTRATION OF ANÆSTHESIA

JOSEPH MCNEARNEY, M.D., St. Louis: In the present day the anæsthetic department of a hospital should be staffed by physician anæsthetists who have had special training in the field of anæsthesia. There is a greater field for medical anæsthetists now than ever before. The young medical graduate who will take special training in this field will be the anæsthetist of the future. Medical schools are beginning to realize that a good knowledge of anæsthesia is essential.

The nurse anæsthetist is an economy to the hospital, but not to the patient. The patient pays the same fee to the hospital for the anæsthetic given by the nurse anæsthetist as he would pay a physician anæsthetist. In my opinion, anæsthetics should be on a flat rate fee basis, in keeping with the economic condition of the clientele of the hospital. The surgeon is then in a position to inform the patient what he will be charged for the anæsthetic in estimating his probable hospital cost.

The hospital feels that it furnishes the equipment and materials and should be compensated for their use—which it should. Nevertheless, the anæsthetist is entitled to remuneration *in proportion to the amount of work done* whether he is working for the hospital on a salary or on a percentage basis.

A rather large savings can be made in the anæsthetic department in the use of gases for anæsthesia by having the proper preliminary medication and using soda lime filters.

EFFICIENCY AND ECONOMICS AS APPLIED TO THE ADMINISTRATION OF FOOD SERVICE

EUGENIA SHRADER, St. Louis: With the present low price level of food commodities it is possible for certain savings to be made in the dietary departments of hospitals. The problem of the dietitian is how great a saving can she bring about without relinquishing her present standard of efficiency.

First of all, it is paramount that there be a well trained dietary staff to direct and help carry on the work of the department. With such a staff we know that only adequate diets would be considered in planning economical menus.

Since a centralized purchasing department is the general rule in most institutions, it behooves the dietitian to be in close contact with this department. To effect savings and add variety to her menu the dietitian must be responsive to any "quick buys" which the purchasing department feels advisable. On the other hand, the purchasing department must be just as flexible and responsive to the needs of the dietary department.

The preparation and service of foods are exceedingly important. The dietary staff should ever be on the alert for variety in the preparation of foodstuffs. Therefore, the kitchen should also be an experimental station where new recipes are tested on a small scale before being incorporated in the menu. This can be made a valuable part of the practical training of student dietitians.

The insulated cart seems to be the most efficient and economical means of serving food to the ward and also to the private patient. Astonishing savings can be effected by installing cafeteria service for hospital personnel.

The student nurse plays an important rôle in this economic readjustment. In the dietetic laboratory she should be taught the importance of a well balanced diet, how this diet may be adjusted to meet the demands of certain diseases. She should also be taught the value of food and food service from an economic as well as a therapeutic standpoint. The attitude toward food that the student nurse gains through her laboratory training and experience will be one of the deciding factors as to her degree of usefulness in the ward food service.

EFFICIENCY AND ECONOMICS IN HANDLING SURGICAL DRESSINGS AND SUPPLIES

SISTER PHILOMENA, R.N., St. Louis: The hospital executive faces the problem of giving prompt, efficient, adequate hospitalization to the sick of the community with less money than has ever before been at his or her disposal. Economy in the handling of surgical dressings and supplies can be made a great aid toward this end.

Adequate supervision of the preparation of supplies, their distribution, and the procedures necessary for their repeated use and maintenance can be made to yield large economies.

Central distribution stations seem particularly economical. Such details as the size of the gauze packs, the carefully studied distribution of the packs to the various surgical units, and attention to the special desires of the attending surgeons yield valuable results. If different grades of gauze are purchased for different purposes, economies are also bound to result. The preparation of iodoform gauze drains cut into proper lengths minimizes waste, and through a practical method hospitals can easily effect the proper sterilization of such drains.

Savings can be effected in the preparation of physiological saline solutions if the needs of the various departments of the hospital are kept in mind in planning strength and size of containers. The proper handling of surgical needles and sutures reduces costs to rather an appreciable degree.

The use of packs, for example, for laparotomy operations, blood transfusions, etc. containing all the equipment usually found to be necessary for each particular operation, has also been found to result in diminution in costs.

Economical administration promotes co-operation within a department and thereby insures increased efficiency.

GREETINGS FROM TRUSTEES OF THE HOSPITAL OF ST. LOUIS

SIDNEY ROTHSCHILD, St. Louis: Overexpansion and a disregard for the law of supply and demand prevalent in every phase of our national life affect hospitals in the same way as they do any other business organization or industrial concern. Market fluctuations that have affected business investments and wiped out fortunes have also resulted in a depreciation of hospital investments and greatly reduced the income from hospital endowment funds. Hospital trustees are keenly aware of the financial stress and of community needs at this time. Hospital administrators are business men and women. If they did not possess more than an average amount of business ability, they would not be selected for their positions.

Trustees have a right to expect the most loyal co-operation from superintendents in their efforts to interpret community needs and safeguard community funds. They, in turn, are under just as strong an obligation to be loyal and staunch supporters of the superintendents. We must realize that hospital superintendents have been working under a great handicap to maintain the same standards and service with a greatly depleted income.

Trustees, to whom the administrator is responsible for the execution of hospital policies, are likewise responsible to the community for the judicious expenditure of funds entrusted to their care. It is no small responsibility, for regardless of whether the institution is tax-supported or non-tax-supported, the money comes from the community.

Lowered bed occupancy, hospital deficits, and other problems have created many perplexing situations and anxious moments for hospital trustees and administrators. The hospital as an educational health center is rendering a service that cannot be duplicated by any other institution. But is there any other institution that would be expected to serve the community month after month, year after year, at a financial loss?

The hospital should not be less humanitatian in dealing with the public but more businesslike. We need more definite business policies in hospital management. There should be legislation, moreover, to protect the hospital from exploitation.

CRITERIA TO BE OBSERVED IN SELECTING THE GOVERNING BODY OF A HOSPITAL

C. W. MUNGER, M.D., Valhalla, New York: A governing body of a hospital to be promising, must include variety in its membership as to age, sex, wealth, social position, and business experience. We need straight thinkers on our boards, trustees who will consider matters not only in the light of business, but in terms of human values.

It is perhaps best not to include a physician on the board. Even though he may be entirely unbiased in his medical affiliations, the remainder of the medical staff usually resents his membership and loses sympathy with the purpose of the board. Wealthy men make valuable members if they are active. The ideal situation is to find a wealthy man who is definitely interested and willing to do his share of work.

Women should be represented on the board. It is well worth while, also, to have a representative of each class in community life. Therefore, a man who knows the needs of the working man and has his confidence should be made a trustee.

It is wise to give honorary membership to the principal officers of two or three prominent religious sects of the community. The hospital which can gain the endorsement of clergymen of all faiths will be more consistently supported by the public.

An ideal board of trustees would include an architect, a banker, a lawyer, and a merchant. Care must always be taken, however, to make these trustees from the various walks of life understand that their firms are not to be preferred with the hospital's orders.

The greater his experience in large affairs and management of people, the more readily can the board member be trusted to act wisely in the performance of his duties. Persons of large affairs who have been accustomed to supervise or who have been a part in a working organization are to be desired. The surest way of gaining the interest of the trustee is to give him something definite to do and to keep him supplied with tasks to the extent of his willingness to work.

Care should be exercised so as not to select several persons who are closely related else the public will feel that one family is in control of the hospital. New members need to be educated in the history, the ideals, the traditions, and aims of the organization. We need more young, mentally alive citizens on our boards, but they must not be the "go-getter" salesman and promoter type who refuses to act wisely and with reasonable deliberation.

If our board is carefully selected at first; if we maintain its balance as we make new appointments, it can, with the rarest exceptions, be depended upon to function for the good of the hospital and the community.

Discussion

FRANK C. RAND, St. Louis: Trustees should so guide the hospital that it will help the patient first. It is difficult but necessary that all of us should realize that each hospital patient is an entity within himself—separate and distinct from every other human being—and, so far as it is practicable and possible, should receive sympathetic individual attention and treatment.

A trustee must serve without salary; must be a man of strong constitution, of a low nervous organism, one who is not sensitive to sudden shocks, and of fine recuperative powers.

It is short sighted to delegate to committees of the board—or, for that matter, committees of the staff—functions properly belonging to the administrative officer. Concentration of responsibility facilitates action, for which credit or blame can be definitely fixed.

Various types of human activity differ mostly in form, while in substance there is an underlying analogy that makes them closely akin. To the most casual observer there may be little resemblance between hospital trusteeship and the square circle, but 18 years of experience has developed an empirical knowledge that forces on me the inevitable conclusion that they are of the same family.

RESPONSIBILITY OF THE GOVERNING BODY IN SELECTING THE SUPERINTENDENT

CHRISTOPHER G. PARNALL, M.D., Rochester, New York: It is important that members of hospital boards give careful attention to selection of their own membership. Hospitals both public and private are often greatly handicapped by the astonishing ignorance of members of their boards.

Attempts by boards to administer by committee or individual members the affairs of the hospital have proved inefficient and often disastrous. There should be no division of authority; administrative responsibility should center in a single individual who is employed for the purpose. Except for the executive committee, all committees should be advisory.

The superintendent should be regarded always as the agent of the board. He should be responsible for the employment of all department heads and should be consulted regarding appointments to the medical staff. He must be a leader and should be left free to make decisions for which he is always held responsible. A medical training is a distinct advantage. If a layman, he should have access to medical advice, and ability to judge of its soundness. He must be alive to the problems of the medical profession and sympathetic with medical progress.

Until hospital boards generally appreciate the necessity for executives of real caliber and offer inducement in opportunities and compensation, which will make hospital administration an attractive career, the individual board will face its major problem when it becomes necessary for it to obtain the services of an executive who can be relied upon to direct the destinities of a modern hospital satisfactorily to its board, its medical staff, and its community.

HOW HOSPITAL TRUSTEES CAN KEEP ABREAST WITH THE ADVANCES IN HOSPITAL ADMINISTRATION

MATTHEW O. FOLEY, Chicago: The best, most practical, and most satisfactory way for a trustee to keep abreast of the times in hospital administration is for that trustee to attend board meetings regularly and listen to what the superintendent has to report. Besides giving an account of the current operation of the hospital, the progressive superintendent will try to help board members get an idea of trends and developments in the field, and so attendance at a properly organized and well conducted board meeting is a practical education for a trustee.

Reading journals, attending conventions and conferences, actively working on committees are most helpful in keeping the trustee abreast with the advances in hospital administration. But if the trustee will attend board meetings, he will learn much about progress in the field of hospital administration which will make more valuable his service on the board.

There are far too many hospital boards which utterly fail to appreciate the responsibilities of their superintendents and the relation of the superintendent to the board. There are many hospital board meetings at which the superintendent is not permitted to be present, and there are too many hospitals in which the executive agent of the board is overwhelmed with detailed tasks, ranging from fixing a broken down piece of equipment to collecting overdue accounts.

Too many hospital boards employ a superintendent presumably because they believe that this person knows more about hospital administration than any of their number, and then they proceed to compel this superintendent to operate the hospital the way they want it operated.

If the superintendent is given a voice at board meetings that is heard with due attention, if he is not hampered with trivial details, if he is accorded the co-operation and wholehearted support of the board, he will be able to render better service to all concerned and so will improve the administration of the hospital.

REMOVING HOSPITALS FROM THE INFLUENCE OF POLITICS

JOHN A. MCNAMARA, Chicago: Municipal, county, or tax-supported hospitals should be as much above suspicion as are our public schools and their administration should be on as high a level, if possible on a higher level, because to hospitals is entrusted the task of returning to society the ill and the injured.

When mismanaged institutions in which graft is rampant, in which death rates are high, and in which all ethics and standards of the medical profession are openly disregarded, are removed from the list of hospitals approved by the American College of Surgeons, from the list of hospitals approved by the American Medical Association for interne training, and from all other lists, then, and not until then, will the municipalities clean house and give to the taxpayers institutions wherein the indigent sick and injured may be cared for in an adequate manner.

It is an imposition on our young doctors and internes to subject them to the influence of poorly equipped, managed, and staffed institutions. They can only learn vicious tricks and take away with them into practice a large number of false ideas and no ideals at all.

We must not neglect the health of the whole community; we must not allow members of society to die because of improper treatment while we sit idly by and politicians fatten on the misfortunes of citizens. It is time that all good hospitals band together and protest that politically dirty and corrupt institutions are removed from the lists of accrediting organizations; they must ask that a full survey be made of these institutions and that they be taken from the lists unless politics are completely divorced from all healing institutions.

Discussion

EDGAR P. HOGAN, M.D., Birmingham, Alabama: It must be recognized that to remove hospitals from the influence of politics is a difficult problem. So many tax-supported institutions are still under political control because those who are responsible for the management of hospitals have not informed the people who are omnipotent in making laws, as to what form of government and administration is best for the hospitals.

It is by legislative enactment that laws must be secured which will stabilize hospitals in government and remove them from the destructive influence of politics. In many states, counties, and cities this has been done. Alabama, many years ago, by legislative enactment created a non-political board for the control of Bryce Hospital for the insane. The State Board of Health of Alabama and the boards in each county are elected by the state medical society and county medical societies, respectively. They have entire authority and responsibility for the public health work of the state and the expenditure of the public health appropriations.

For county and city hospitals a state law, creating hospital boards consisting of five members, one of whom would be elected every 2 years for a period of 10 years, would be a most excellent one. Such a board would remove tax supported hospitals from the influence of politics.

Non-political boards of tax supported hospitals, clinics, and dispensaries can limit the work to charity cases only. Political boards cannot. It is in the interest of the tax supported hospitals, the taxpayers, politicians, private hospitals, the medical and nursing professions, and the general good that politics be eliminated absolutely from the control of hospitals.

HANDLING OF COMMUNICABLE DISEASES IN CONNECTION WITH A GENERAL HOSPITAL

T. R. PONTON, M.D., Augusta, Georgia: To accept and treat in a general hospital patients suffering from communicable diseases is a perfectly safe procedure, and in the smaller city where the number of such patients is not sufficiently great to warrant the construction and maintenance of a special hospital for communicable diseases, it is the logical method of protecting other members of the community while giving the patients proper care.

Correct diagnosis is the first great essential. It is the unrecognized case that infects others and may even cause an epidemic.

Proper prophylactic measures should be used. Hospital attendants whether they are to attend communicable diseases or not should have all the recognized forms of immunization unless they are known to be immune.

For the care of patients suffering from communicable diseases proper facilities must be afforded. Whenever possible, each patient should be placed in a room by himself. Failing the individual room, the next best facility is the cubicle in which a definite space is allocated to each bed and a partial partition placed at each side of this space. When the cubicle cannot be provided patients can be accommodated with safety in the general ward so long as they are grouped properly and the beds spaced sufficiently apart.

Antiseptics should have little place in the management of communicable diseases. For sterilization of some articles used around the patient they are necessary, but the basin of biniodide so frequently seen at the bedside is a menace which should be avoided. It gives a sense of security which is absolutely false.

Soap and water are the key to proper technique. For 15 years I have used soap and water with cross-infection so rare as to be negligible. If one factor could be selected as the most important it would be running water. If you use plenty of soap and water and follow the dictates of medical science in measures of prophylaxis, you may be assured that in the general hospital patients known to be suffering from communicable diseases may be cared for with perfect safety to other patients and to attendants.

Discussion

WALTER C. D. KIRCHNER, M.D., St. Louis: While it may be true that communicable diseases may be treated in general wards of hospitals in smaller communities, I believe that in the larger cities it is distinctly desirable to establish and maintain separate isolation wards.

A careful diagnosis relative to infectious diseases is most important. No patient should be admitted to the general wards or open services where there is a suspicion of communicable disease. Cases that are suspicious, such as typhoid, measles, diphtheria, etc., should be very carefully examined so that proper assignment to the ward or division may be made.

In the City Hospital, for instance, and especially in the children's ward, all children are isolated in rooms for a certain period until it is assured that infectious diseases may be ruled out. It is important that preliminary examinations such as throat cul-

tures, blood cultures, etc., be made at the earliest possible moment so that the possibility of infection may be determined.

Unless the hospital is provided with proper facilities for handling communicable diseases, it is difficult to prevent the spreading of contagion. Chlorinated lime is an important preparation in handling infectious diseases because it has a distinct antiseptic value and can be used readily and easily.

THE INDIVIDUAL DOCTOR'S RESPONSIBILITY FOR CLINICAL RECORDS

WALTER F. COLE, M.D., Greensboro, North Carolina: We as physicians are responsible for clinical records. We are not only responsible; we are obligated, first of all, to our hospital organization. The standing of a hospital in a community affects the standing of its staff. Its organization depends upon the loyalty of its members.

We are obligated to our colleagues, especially to the future physicians now in the making. Careful directions and records of the blunders we have made will act as a beacon light to warn them of impending danger.

The records that we make are future protection to ourselves in legal matters. Again, it gives us a better grasp, a broader viewpoint of our case, which enables us to formulate a clearer and more concise idea of the pathology involved. When we make a record of a case, we are writing the life history of our association with the medical profession.

Our obligation is greatest to our patients. Every patient is entitled to a careful and concise record of our findings so that in case of necessity it may be used to his advantage in the future. The record enables the physician to make a finer diagnosis of his case, and thus to better fulfill his duties as consultant and surgeon.

Do you direct your staff to make these histories because they are required by the American College of Surgeons, or do you insist upon them because of the value of the record? Has it ever occurred to you to meet with the staff of your hospital, bringing with you the criticism of your records by the American College of Surgeons for discussion, so that better co-operation may be enlisted? It should be remembered that one of the chief criteria upon which the American College of Surgeons classifies your hospital is based upon the completeness, clearness, and accuracy with which you record the work accomplished by your staff.

Discussion

DEWELL GANN, JR., M.D., Little Rock, Arkansas: There is no department in the hospital where the co-operation of the doctor is more essential than in the record room. Here the doctor and the record librarian need the help and co-operation of each other in order to secure records of efficient clinical value. The record librarian of today invites and appreciates constructive criticism of her department. She realizes that without such criticism from the doctors who are in a position to recognize the scientific value of a record, her records will be valueless. No matter what amount of ability the record librarian possesses, or how progressive she may be, she cannot succeed in producing scientific case records without the intelligent and vigilant co-operation of every doctor.

Just as the officials of any commercial organization are entitled to know the reasons of the profit and loss in the business, so also the hospital management has a right to an accurate and honest report of the medical service rendered in its hospital. Medical science will be advanced by the accumulation of such data. Authoritative statistics of one hospital combined with those of other hospitals will furnish material for research. As practically all advancement in medical science has been achieved through research work, it is the duty of every doctor to contribute his knowledge to its promotion. Although hospital records have been greatly improved in recent years, they are still found to be inadequate, as has been highly emphasized in the present research work on cancer. In order to overcome this disadvantage, the American College of Surgeons has adopted special cancer sheets which are well worth consideration.

An office-hospital routine which I prepared and am still using at St. Vincent's Infirmary is outlined here in the hope that it may be helpful:

1. During the examination of a patient in the office I dictate in code to a nurse the working diagnosis and what I propose to do.

2. When the nurse takes the patient into an adjoining room so that his clothing may be adjusted, she prepares an admission slip in code which the patient takes to the hospital with instructions to hand it to the record clerk on arrival.

3. After the clerk at the hospital has assigned the patient to a room the slip is handed to a graduate nurse in charge of my patients at the hospital who transfers the working diagnosis on the slip to the progress record together with my recommendations for hospital procedure. I need not see the patient further that day unless I so desire, and the following morning the chart is brought to the operating room with the patient. It is only necessary for me to consult the progress record to know what I am to do for the patient, and unless I have been notified of some oversight or irregularity, I know the patient is ready for operation.

4. On completion of the operation I dictate to a dictaphone the postoperative diagnosis, findings, and procedure.

5. After the morning's work is completed, the hospital stenographer transcribes the dictation to the "operative chart" and this becomes a part of the record.

6. When the patient is discharged from the hospital my nurse prepares a card, similar to the usual summary card which is sent to my office for ready reference, containing all necessary data for essential follow-up, financial and otherwise.

This system takes care of all essential data except the history, physical examination, and laboratory work at the hospital.

THE VALUE AND SCOPE OF MEDICAL SOCIAL WORK IN THE HOSPITAL

GRACE BEALS FERGUSON, St. Louis: It is true that medical social work has made its most significant contribution in the study and treatment of medical rather than surgical problems. The reason for this is perhaps obvious, in that medical problems are much more frequently complicated by personal and environmental situations than are those dealt with by the surgeon. The treatment of diabetes or tuberculosis, for example, depends upon the emotional acceptance of the regimen, the economic status, and the participation by the patient to a far greater degree than does the treatment of a fracture.

There are, however, two aspects of surgical treatment to which experience has shown that the social worker can make a valuable contribution; first, in regard to follow-up; and second, in regard to the adjustment of mental and emotional concomitants which we know today can seriously complicate the treatment of patients cared for by a surgeon.

Social studies have shown that efforts on the part of the social worker to secure the return of a patient for a follow-up examination after a period of time has elapsed are usually unsuccessful. On the other hand, if the social worker interviews the patient when he is first being admitted to the clinic or hospital, lapses and failures to return decrease noticeably.

It is the social worker's responsibility to counteract any adverse objective factors in the patient's environment. She can be of untold assistance to the surgeon in helping the patient adopt a better mental attitude toward his condition, and encouraging him to co-operate with the doctor and the hospital so that his recovery from the operation may be effected in as brief a time as possible.

Discussion

ROBERT E. NEFF, Iowa City, Iowa: Time was when the hospital was merely a boarding house for the sick paying no more attention to its discharged patients than hotels today pay to their departing guests. The hospital should be vitally concerned in the discharged patient and assume responsibility to the extent that interest is maintained in the patient until he becomes restored to a normal social environment after leaving the hospital.

The follow-up work on discharged patients is the direct responsibility of the social service department and enables the hospital to round out the treatment of patients and restore them to normal environment; in other words, finish the job. Without follow-up work on patients, the hospital has no assurance that the job has been completed and may expect to have back on its hands many patients whose hospital treatment has been for naught, chiefly for the reason that proper control during convalescent care had not been exercised over the social factors necessary for a complete cure.

To handle this problem adequately for the hospital, there must be trained workers who possess specialized training in the basic principles of social work, together with knowledge bearing on etiology, methods of treatment, and prognosis in the various diseases. The proper handling of the patient from the standpoint of social needs must be based largely upon medical factors of which the social worker must have at least a general knowledge and which must be supplemented by the directions and findings of the physician.

Many hospitals have established social service departments on the justification of economic considerations. Financial investigation of prospective patients by social service has rendered very definite financial benefits to the hospital. Also, the matter of the rapid turnover of patients which represents an economic factor of no small importance, is greatly aided by social service.

If we are to treat the patient as well as the disease, we must treat him personally, emotionally, and socially—this may be accomplished through the means of well trained and experienced social workers.

HOW THE MEDICAL SOCIAL WORKER CAN ASSIST IN THE PRESENT ECONOMIC SITUATION

RUTH LEWIS, St. Louis: The time at which the social worker touches most directly the economic affairs of the hospital is on the admission of patients. This is not a routine procedure, and because of its large social components may logically be performed by a social worker. She may determine the patient's eligibility for admission, set the rate he is to pay, and as well influence the collection of the account.

At a time when free and part pay beds are at a premium, the selective utilization of those available is a grave responsibility of the hospital even though the choice of who shall occupy a particular free bed may not swell the income of the hospital. The medical social worker either through her previous contacts with the patients in the clinic or her relations with other social agencies may be able to contribute information about the patient which will help to make a wise decision regarding his admission.

The pressure on the free and part pay beds may be partially relieved in many hospitals by the efforts of the social worker in reducing the length of stay of patients. In cases where a close working relationship exists between the physician and the social worker, and a plan for the after-care of the patient has been made before the patient's admission or early thereafter, the average length of stay has been markedly reduced.

When patients are refused admittance to the hospital and feel that they are being unreasonably treated because the hospital is not full and is partially supported by the community, it is the social worker's problem to interpret the hospital's present situation and demonstrate convincingly the practical alternative of home care.

It is in service to patients that the social service department makes its greatest contribution to the hospital. In order to insure complete treatment to its patients the hospital must know the social situations complicating medical care. These the medical social worker supplies. She is also interpreting the hospital's financial limitations and needs. The family, the employer, the minister, the school teacher, the lodge brother, the judge, the family physician are all channels through which the social worker may pass on this information of the hospital's services and needs through her daily contacts on behalf of individual patients.

THE RÔLE OF THE SOCIAL WORKER IN THE DIAGNOSIS AND TREATMENT OF CANCER

ELEANOR COCKERILL, St. Louis: Cancer, a disease ranking second as a cause of death in the United States, offers a real challenge to the social worker. As the medical profession seeks to perfect the diagnosis and treatment of this disease, there is an increasing realization of the vital influence of the social factors which are involved.

The social worker's task is to understand as completely as possible the problem of each individual patient. She arrives at this understanding by acquainting herself with the details of his physical condition—the type and stage of the cancer, the therapy advised, and the possibility of arrest or cure—and by inquiring into his social situation which enables her to evaluate the possible effect of the disease and the obstacles to treatment and observation which may arise. With this information in her possession, she is equipped to bring to the aid of the surgeon any pertinent observations she has made which have a bearing upon his plan. She becomes adviser and interpreter to the patient and his family, supplementing earlier explanations by the surgeon, anticipating and meeting difficulties in carrying out the plan of treatment, and bringing into action any other social adjustment indicated. Community contacts are strengthened and new resources enlisted.

If the social worker is successful in her rôle, there will be no necessity for the follow-up of delinquent patients. The foundation she lays through interpretation and guidance is permanent and lasting. The surgeon will be able to complete his diagnostic study, to carry out a plan of treatment and observe the results through the years which follow. As the social worker carries on her program with the patients assigned to her care, she becomes an effective channel through which information about cancer can be disseminated to the general public. She thus contributes to the diagnostic, treatment, research, and educational phases of the cancer program through her rôle as interpreter to surgeon, patient, and community.

Discussion

FRANK L. RECTOR, M.D., Evanston, Illinois: Granted the co-operation of the attending physician, which it is inconceivable not to have, the problem of the social worker is to bring to the physician and the hospital regular reports of the health and welfare of the patient. No fixed rules can be laid down by which this may be done. It is largely dependent upon the common sense of the social worker and her ability to take advantage of all resources that will be of assistance in her work.

The social worker is aided greatly in her work if she is also a trained nurse. She can then evaluate the conditions with a professional eye as well as with her social training, and can thereby render a twofold service that is of special value.

In almost every instance it is best to tell the patient that he has cancer. This is now done in some hospitals doing cancer work and results in the best co-operation between the staff and the patients.

Should convalescent cancer patients, especially hopeless cases, be cared for in the hospital or in their homes? One large cancer hospital, the Memorial Hospital in New York, has answered this question by getting such patients out of the hospital at the earliest possible moment and back at home among friends and relatives. Here they are cared for by home visitors, trained nurses with experience in social work. These visitors render a splendid service by their regular visits to these patients, at times only for a friendly call and again as nurses to render such professional care as is indicated. The medical staff of this hospital has repeatedly stated in public that it would never recommend special cancer work in any hospital unless and until such a follow-up is available in the homes of its patients.

A MODERN MEDICAL AND SURGICAL CHEST SERVICE AT BARNES HOSPITAL

JACOB J. SINGER, M.D., St. Louis: That the medical and surgical chest service at Barnes Hospital was begun in a space formerly used as a storage room for trunks is ample evidence to prove that good work can be done with limited facilities so long as the personnel is properly trained and willing.

Particular emphasis has been placed upon diseases of the lungs in this department but the scope of thoracic surgery is by no means confined to those organs. Because of the development of safe methods of approach and attack, not only do many lesions of the lung respond to surgical measures, but various intrathoracic tumors can now be safely removed, and even certain conditions of the heart itself can be attacked successfully.

At the present time we have a large fluoroscopy room, well ventilated, two operating rooms connected with the fluoroscopy room which is also connected with the chest radiographic room. The doors are wide enough so that a patient can be rolled into the various rooms without having to leave his bed and all necessary examinations, and treatments made. A large right-angled room, used as a passageway to and from the fluoroscopy room, has X-ray

boxes and stereoscopic apparatus; the walls have moldings so that exhibitions of unusual chest photographs can be displayed for meetings and conventions. Private offices for the medical staff and secretary, and a large classroom and dressing rooms complete the physical equipment.

The second floor of the new Rand Johnson Memorial Building of Barnes Hospital was set aside for patients requiring treatment in the thoracic field. This floor is connected by halls with the diagnostic service. It is modeled after the best tuberculosis sanatoria with porch facilities for all patients. A graduate nurse, especially trained in thoracic diseases, spends her entire time in the chest service and a secretary looks after records, lantern slides, and teaching paraphernalia; both add greatly to the usefulness of this division for purposes of training and instruction. A special library in this field is rapidly becoming accumulated.

The chest floor in the Rand Johnson Memorial Building furnishes the best possible conditions for the care and treatment of chest patients; gives facilities for isolation; is flexible so that the number of patients can readily, and on short notice, be increased or diminished; is so arranged that patients desiring or needing accommodations varying from the free ward patient, ward pay patient, semi-private patient, to the private patient can be received; the time of the professional personnel, including the visiting doctors, internes, nurses, dietitians, attendants, orderlies, in fact all who come in contact with the patients, is conserved to the greatest possible extent.

Discussion

LOUIS H. BURLINGHAM, M.D., St. Louis: Shall patients with tuberculosis be admitted to general hospitals? Outstanding authorities on tuberculosis are agreed that tuberculous patients should be admitted to general hospitals where provisions can be made for their care.

Sanatoria are often too far removed from large medical centers. Moreover, the close connection of the large community hospital with teaching facilities makes it possible for future medical men to have the benefit of learning how to diagnose and treat such cases under discussion.

It is necessary for the general hospital to meet the advances made in thoracic work and to adopt the proper facilities in line with changing conditions.

EDITOR'S NOTE—Two afternoons during the Hospital Conference were devoted to round table conferences dealing with administrative, professional, economic, and social problems affecting hospitals. The Tuesday session was conducted by R. C. BUERKI, M.D., Madison, Wisconsin, superintendent, State of Wisconsin General Hospital; the Wednesday session by ROBERT JOLLY, Houston, Texas; superintendent, Memorial Hospital.

Thursday, October 20, the closing day of the Hospital Conference, was given over to departmental demonstrations in the Jewish and St. Mary's Hospitals, conducted by the superintendents with heads of departments, and included the following demonstrations and discussions: preparedness for emergencies in hospitals; operating room management and procedure in handling major operations; food service with various types of tray set-ups, general and special or therapeutic diets; handling supplies; staff education and nurses' conferences; organization of the hospital with exhibition of organization charts; admission of patients with complete procedure; nursing administration and nursing service; problems associated with clinical records and complete record system; organization and management of the pediatric division with demonstration of certain procedures.